

THE PHILIPPINE AGRICULTURIST

UNIVERSITY OF THE PHILIPPINES PUBLICATIONS SERIES A

CONTENTS

A Study of the Net Duty of Irrigation Water for Lowland Rice in Calamba, Laguna	<i>By Domingo J. Alfonso and Alejandro B. Catambay</i>	87
Educational and Occupational Pursuits of Former Students in the Batangas and Ilocos Norte High Schools	<i>By Francisco M. Sacay, Gil F. Saguiguit and Faustino Brual</i>	114
A Study of the Influence of Two Chick Rations and Two Methods of Brooding on the Rate of Growth and Mortality of Chicks	<i>By Leopoldo S. Castillo ..</i>	124
Photochlorination of a Homologous Series of Fatty Acids from Coconut Oil	<i>By Enrique O. Bondoc and Julian Banzon</i>	138
Variability in Plant and Grain Characters of Fortuna Rice as Influenced by Methods of Culture	<i>By José M. Capinpin and Restituto R. Lopez</i>	150
Relation in Ducks between Duration of Incubation and Sex	<i>By F. M. Fronda and Ponce B. H. Infante ..</i>	165
Seraup Kechil 36 and Guinangang as Primary Crops in Succession to a Secondary Rice Crop	<i>By Valeriano C. Calma and Antonio R. Piga ..</i>	173
Effects of Copra Meal on Certain Chemical and Biological Properties of Los Baños Clay Loam	<i>By Victorino C. Andrion ..</i>	178
College and Alumni Notes		183

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A STUDY OF THE NET DUTY OF IRRIGATION WATER FOR LOWLAND RICE IN CALAMBA, LAGUNA ¹

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Physics, and Mathematics*

WITH 7 CHARTS AND 6 TEXT FIGURES

In 1939, only 30 per cent of the total acreage planted to rice was served with some kind of irrigation system;² the remaining 70 per cent was totally dependent upon rainfall for an uncontrolled and uncertain supply of water. Of the irrigated 30 per cent, only a portion had water supply sufficient to support two crops a year.³

The water requirement of a rice crop during the growing season varies with the stage of development of the plant, the relative humidity and temperature of the air, the duration of sunlight, and the wind intensity. A portion of this water requirement is satisfied by the rainfall. The unsatisfied remainder is the fluctuating load on the irrigation system, here called the "net duty of irrigation water". The outstanding value of this fluctuating "net duty" is its maximum, the value for which the irrigation system must be designed.

Many determinations of the duty of irrigation water have been made by measuring the water delivered to the fields in accordance with the irrigation practice prevailing in the place of study; but since in many instances the seepage of water through the dikes, a factor which can neither be entirely eliminated nor measured, is so great, the values obtained in these determinations are of little value.

Gordon (1929) found the prevalent irrigation practice in western Laguna to form three-period curves when plotted against time, the heaviest irrigation being towards maturity of the crop. The entire irrigation period lasted from ten to fifteen weeks, depending upon the rice variety. He also found the average depth of water for Guinang-gang rice to be 10.1 centimeters during the entire irrigation period.

In the intermittent-irrigation method used in Calauan, Laguna, where four to eight irrigations are made during the rice-growing season, Teodoro and Bataclan (1931) noted the following steps:

¹ Experiment Station Contribution No. 1500. Thesis presented by the senior author in partial fulfillment of the requirements for the degree of Master of Science in Agricultural Engineering from the University of the Philippines, July 30, 1948. Prepared in the Department of Agricultural Engineering, Physics, and Mathematics, College of Agriculture, University of the Philippines, first under the direction of Professor Anastasio L. Teodoro and later under the junior author. Read by the junior author before the one-hundred-and-seventy-ninth scientific meeting of the Los Baños Biological Club on September 24, 1948.

² McNUTT, PAUL V. June 8, 1947. Irrigations in the Philippines. Sunday Post Magazine.

³ Calamba, Laguna, the place of the present work, has sufficient water for two rice crops a year.

1. No water is turned in for two to five days after transplanting.⁴
2. Five to ten centimeters of water is turned in for one to two days, and the water is drained off for three to four days.
3. The irrigation and drainage process is repeated seven or eight times until the crop is mature.

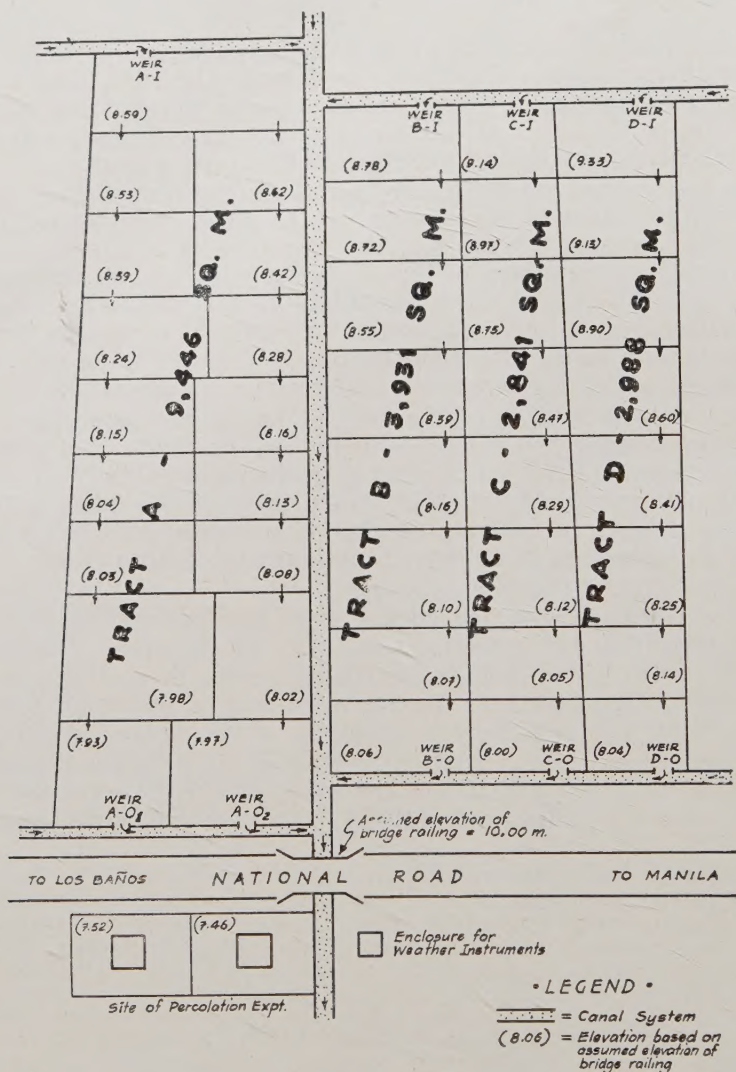


Fig. 1.—Plan of the field where the experiments were conducted.

⁴ The seedlings were raised by the "dapog" method.

Etcheverry and Harding (1943) found the "consumptive" use of rice⁵ under California conditions to be 4 to 4.5 acre-feet to the acre, equivalent to a depth of 48 to 52 inches (122 to 132 cm.) of water. They reported that on clay adobe soils, a total of 60 inches (152 cm.) of irrigation water is necessary to raise a crop, although in actual practice where the soil is more porous or the levees are leaking, 72 to 96 inches (185 to 244 cm.) is required.

It was the purpose of this work to determine the value of the net duty of irrigation water independent of the indeterminate factor of dike seepage. The work consisted of an actual determination of the net duty of irrigation water for a wet-season and a dry-season crop of rice grown in an irrigated field in Calamba, Laguna, from May 10, 1946, to May 9, 1947. In order to qualify the results obtained, records of the weather and of the different farming operations were kept.

MATERIALS AND METHODS

The field

Field tests were conducted on a two-hectare, irrigated, lowland rice field belonging to Dr. Teodora Ochoa-Juliano in Calamba, Laguna. The field (fig. 1) was divided into four plots, designated A, B, C, and D, each with its own water intake and discharge openings. The irrigation system serving the field is owned by the municipality of Calamba, and is adequate to supply the water requirements of two rice crops a year.

The soil profile (fig. 2) taken from a well dug in the vicinity of the field showed a layer of surface soil about 38 cm. (15 in.) thick, underlaid with layers of adobe to a depth of about 12 meters (39 ft.). Below this depth lay the water-bearing sand stratum and the water table, which was 12.5 meters (41 ft.) deep.

The field was worked by a tenant farmer, Damaso Mamino, who had had the management of this piece of land continuously for forty-one years. Two crops of rice are grown each year. The tenant's cultural and irrigation methods may be taken as representative of the practice in the Calamba rice region.

The crop season begins with the repair of the irrigation canals. They are weeded, widened, or deepened as needed. The diversion dams across the supply canals (fig. 3) are then repaired and adjusted to divert the desired flow into the paddies. While the soil is soaking, the paddy dikes are repaired. The grass growth on the sides of the dikes are trimmed off, then replaced with a plastering of fresh mud. Weak spots are strengthened and cracks and holes closed. However, water is so abundant in this locality that the dikes are never really made as watertight as in places where rain water must be collected and held for the duration of the season.

The ground is plowed once, then fallowed for two weeks to rot

⁵ This is the water transpired by the plant and evaporated from the ground, or, as designated in this study, the "total evaporation".

the straw and the weeds. The first harrowing breaks up the clods. The second puddles the soil into mud and buries the remaining straw and weeds. The third levels the mud surface and is immediately followed by the transplanting of the seedlings, which have been raised by the "dapog" method.

After transplanting, no water is run in for a few days until the plants have straightened and started to grow. Then the water level is increased to keep pace with the growth of the plants. The fields are kept in continuous submergence until two weeks before the harvest, at which time, the dams diverting the canal water into the fields are demolished, and the fields are allowed to dry up until the

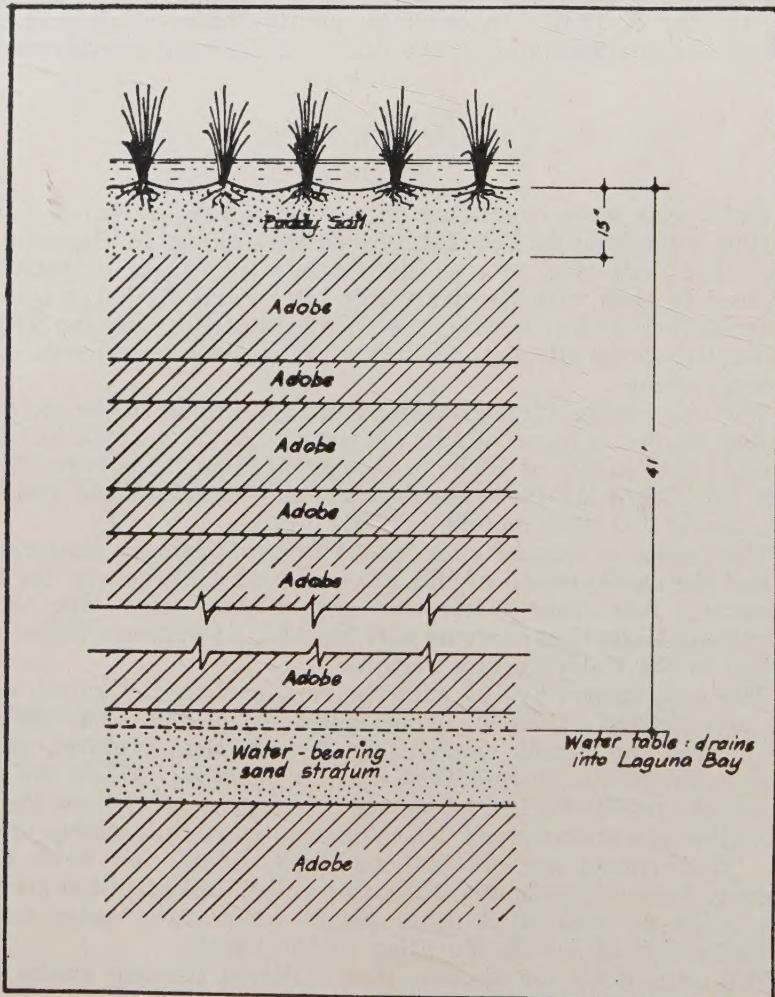


Fig. 2.—Soil profile taken from a well dug close to the field under study.

following season. One weeding operation about the middle of the growing season is the only cultural care given the crop.

Two successive crops of the Guinangang rice variety were studied. The first, a regular wet-season crop, was transplanted on June 22, 1946, and harvested on October 15, 1949, with a period of

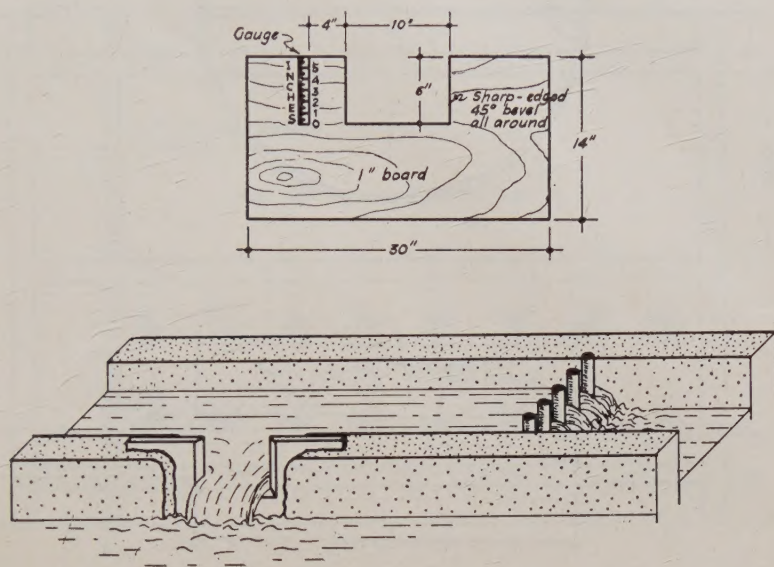


Fig. 3.—The weir used in the experiment. Upper figure shows the upstream-side view of weir. Lower figure is the sketch of a weir installed in an intake opening.

growth of 122 days. The second, a dry-season crop, was transplanted on December 18, 1946, and harvested on April 10, 1947, or 120 days later.

The apparatus used

The following apparatus were used in the study:

1. A pair of wet- and dry-bulb thermometers, Taylor, U.S.A., office model, the unit reading being two degrees Fahrenheit.
2. One anemometer, Friez, U.S.A., U.S. Army Signal Corps, reading to the nearest hundredth of a mile of wind travel.
3. One wind vane, attached to the anemometer, Friez, U.S.A.
4. One improvised rain gauge patterned closely after the standard U.S. Weather Bureau rain gauge.
5. One improvised evaporimeter (fig. 6, upper right hand figure).
6. Nine wooden weirs (fig. 3).

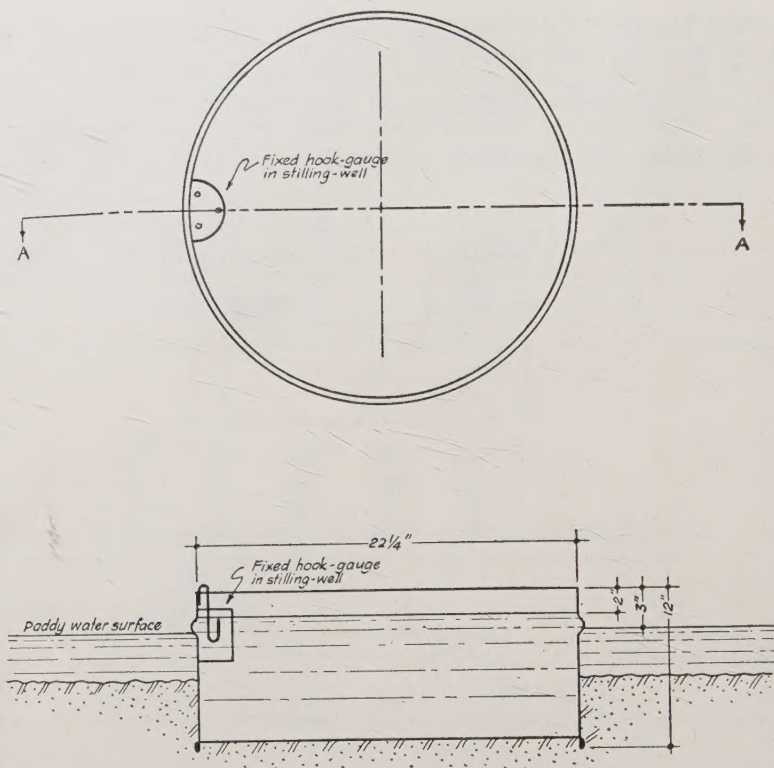
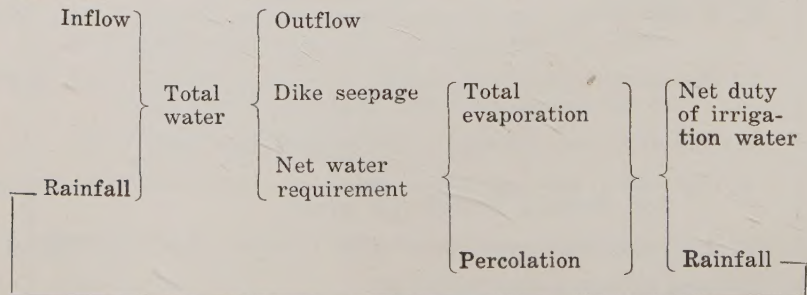


Fig. 4.—The improvised evaporimeter used in the experiment. Upper figure is the top view and the lower figure the vertical section A-A.

7. Six improvised fixed hook gauges (fig. 5).
8. Five improvised adjustable hook gauges.
9. Six concrete tanks in the Agricultural Botany laboratory of the College of Agriculture (fig. 5).
10. One stop watch (fig. 6).
11. One measuring tank for water (fig. 6).
12. Rules, calibrated in different units.

Method of conducting the experiments

The method of conducting the experiments is shown graphically as follows:



The total water which entered the field under test was made up of the inflow and of the rainfall. Part of this total water passed out directly through the outlet weirs as outflow, and an unknown quantity

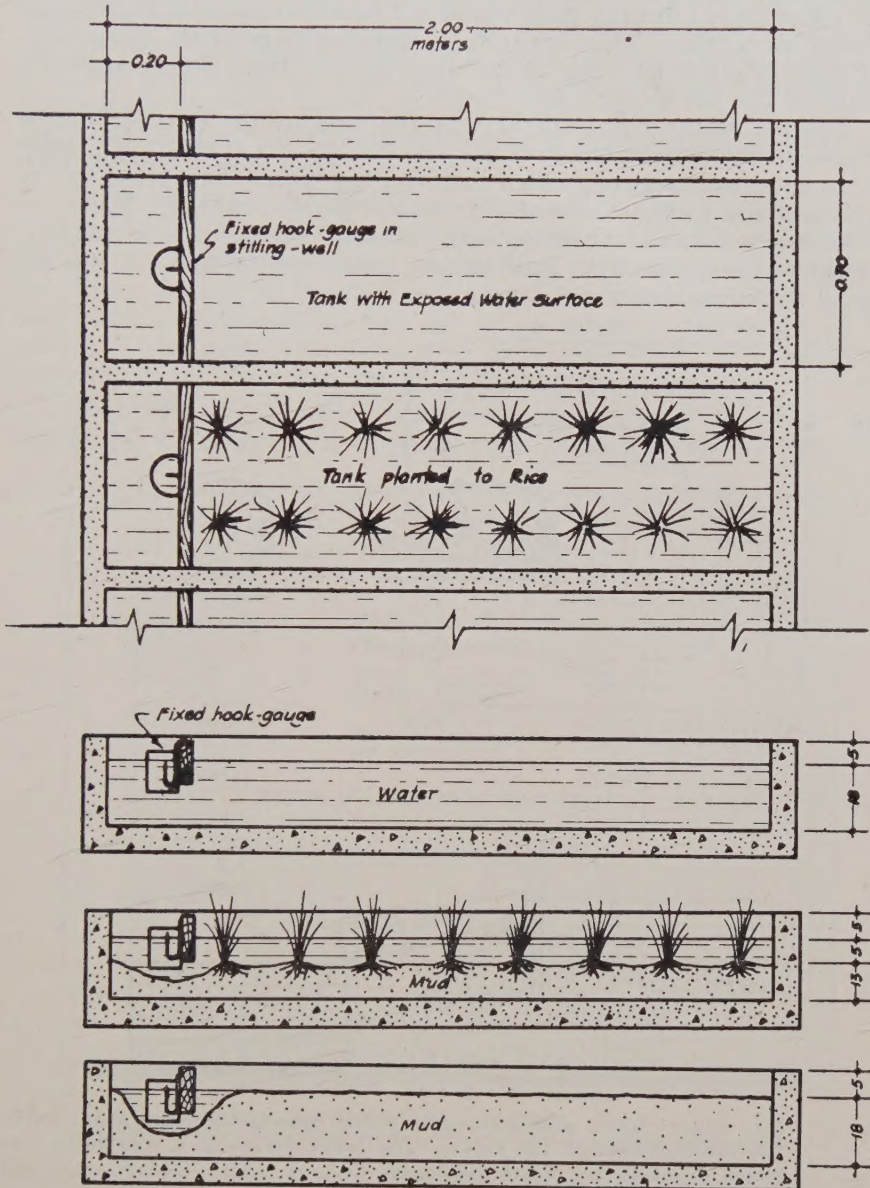


Fig. 5.—Set-up for the evaporation experiment. From top to bottom: Top view of concrete tanks in the College of Agriculture. Lengthwise vertical section through a tank with freely exposed water surface. Lengthwise vertical section through a tank with plants. Lengthwise vertical section through tank with saturated mud surface.

leaked out through the cracks and holes in the dikes as dike seepage. The outflow and the dike seepage were recovered by the lower canal system and used in the fields of lower elevation. The portion of the total water which did not pass out of the paddies was considered used by the rice plants. This amount of water which would have been sufficient to allow the crop to mature, had the dikes been watertight was called the net water requirement.

The net water requirement was the sum of the percolation, or the water that penetrated into the soil during the irrigation period, and the total evaporation, which included the water transpired by the plants and the water evaporated from the paddy surface. The rainfall subtracted from the computed value of the net water requirement gave the theoretical load on the irrigation system, or the net duty of the irrigation water.

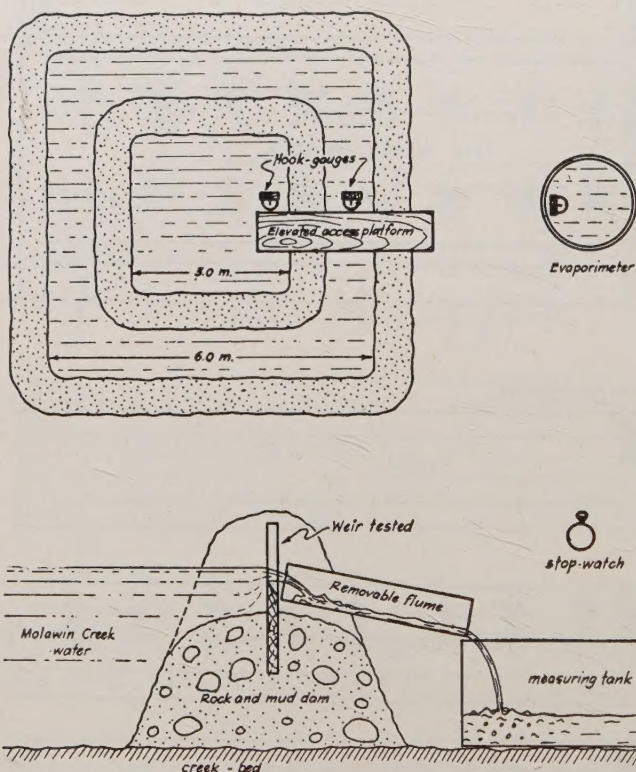


Fig. 6.—The upper figure shows the set-up for percolation experiment, with the evaporimeter at the right. The lower figure is a schematic diagram of set-up for weir calibration.

The field tests

On May 9, 1946, weirs were set up to measure the water passing through the inflow and outflow openings of plots A and B (fig. 1). In consultation with the tenant the weirs were so placed that their

height would not change the customary use of irrigation water. On the same day, a rain gauge and an evaporimeter (fig. 4) were set up in the field. A pair of wet- and dry-bulb thermometers was installed under the farmhouse. The height of the water falling over the weirs and the thermometer readings were taken thrice daily: at 7:00 a.m., at 12:00 noon, and at 5:00 p.m. The evaporimeter and the rain gauge were read and reset every morning at seven. A record of the different farming operations, the hours of work, expenses, yield, and other pertinent data were also kept.

On November 14, 1946, four more weirs were installed at the inflow and outflow openings of plots C and D (fig. 1). The following day, an anemometer and a wind vane were set up in a corner of the field. In each of the paddies nearest the intake openings, a stake calibrated in centimeters was set up to measure the depth of the water. These additional apparatus were read three times daily, together with the first ones installed during the first crop.

To obtain the characteristic discharge curve of the weirs used (chart 1), a wooden weir identical with those used in the field tests

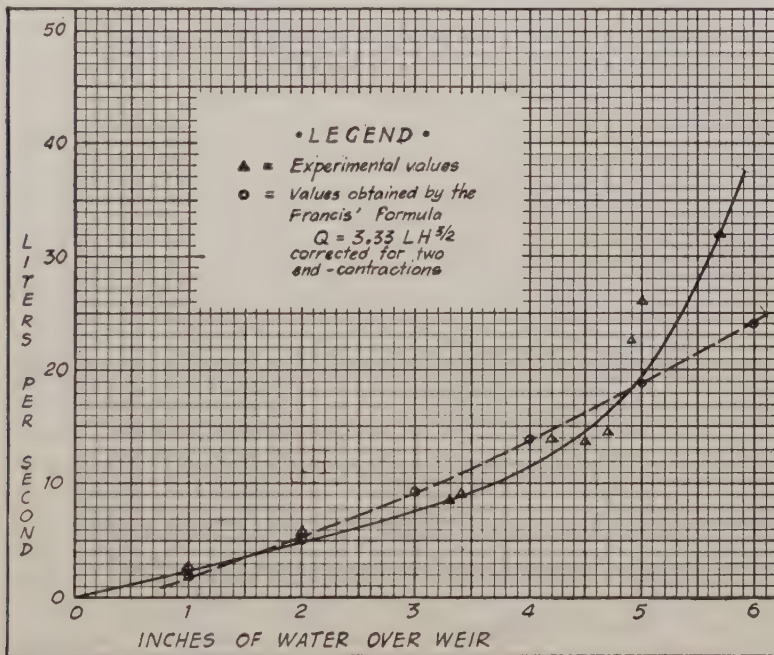


Chart 1.—Actual discharge curve compared with the theoretical discharge curve obtained by Francis' formula.

was calibrated and placed in the bed of the Molawin Creek in the College of Agriculture (fig. 6) on May 1, 1947.

On May 10, 1947, an experiment was made in the Agricultural Botany laboratory to compare the total evaporation, which included both the transpiration from the plants and the evaporation from the water surface of the paddy, with the evaporation from the exposed water surface of the pan-evaporimeter. Six watertight tanks (fig. 5) were filled with mud and water to simulate rice paddies. Tanks 1, 3, and 5 were planted to rice in a manner simulating actual field conditions. The rice planting material available at that time of the year, however, was already in the booting stage. The rice stools were carefully transplanted to the tanks with as little disturbance to their root systems as possible. Alternate tanks 2, 4, and 6 were left with their water surfaces exposed. At definite intervals, the amount of water lost from each tank was determined by measuring the water needed to restore the level to the original height indicated by the fixed hook gauges. The water lost by the tanks with the rice plants represented the total evaporation; the water lost by the tank without plants, the evaporation from the free water surface. The ratio obtained by dividing the total evaporation by evaporation from the free surface expressed mathematically the relationship between the two values. This experiment, which ended on June 11, 1947, did not include the period between transplanting and flowering of the crop. To determine the ratio of the rate of evaporation from a mud surface to the rate of evaporation from free water exposure, an experiment was conducted on May 28, 1947. Tanks 4 and 6 of the preceding experiment were used. Tank 6 was filled with mud to simulate a rice paddy ready for transplanting (fig. 5), and tank 4 was left with a free water surface. As in the preceding experiment, the amount of water lost by each tank through evaporation was taken at definite intervals, and the desired ratio obtained.

On June 5, 1947, an experiment was run at Calamba to determine the rate of downward percolation of water into the soil. Two paddies were plowed and harrowed to a tilth ready for transplanting. At the center of each paddy, a three-meter square (fig. 6 upper figure) was enclosed by dikes carefully constructed to be as watertight as possible. The soil within the enclosed square was not disturbed. A second square, six meters on each side, was built with dikes around the first, all sides equidistant from those of the enclosed square. The inner square and the space between the inner and outer dikes were filled with water carefully adjusted to the same level. The evaporimeter was set up close to the squares to measure the evaporation from the free water surface. By means of hook gauges, the fall of the water level in the inner squares was measured and the level of water in the surrounding square was constantly adjusted to the level of the water in the inner square. The fall of the water level in the inner square represented the loss through evaporation in the air, sideward seepage through the en-

closing dikes, and downward percolation into the ground. Since the evaporation was measured by the evaporimeter and the sideward seepage was prevented by maintaining the same level of water inside the inner square and in the enclosing square, the percolation loss was obtained by subtracting the evaporation loss from the total drop.

For lack of facilities the experiments could not be performed more accurately than they have been in the present work. Most of the apparatus were improvised. Owing to the distance of 14 kilometers from College to Calamba, the reading of the instruments was entrusted to the farmer's son, for which reason, the scales were made as simple as possible, and the time of the readings fixed to suit the convenience of the laborer. Straw floating on the water and the buoyant corms of the field "apulid," *Cyperus* sp., collected at the lips of the weirs, interfered with the flow measurements.

Owing to the lack of facilities, too, the determination of the total evaporation was not made directly at the same time and in the place of the field tests but later and in the college laboratory.

The data presented were obtained from two successive rice crops over a period of 52 weeks, from May 10, 1946, to May 9, 1947. The data for the first crop were taken from the first to the 27th week (table 1) and those for the second crop, from the 28th to the 52nd (table 2).

As the computation of the results was repeated 52 times, once for each week, a single illustration suffices to show the entire process. The data for the 5th week, contained in table 1, were computed according to the following methods:

Computation of the inflow and outflow. As stated above, the weir readings were taken three times a day. With the morning readings considered good for 5 hours, the noon readings for 5 hours, and the afternoon readings for 14 hours, the weekly mean weir readings were obtained as follows:

INFLOW		OUTFLOW		
A-I (in.)	B-I (in.)	A-01 (in.)	A-0 ₂ (in.)	B-0 (in.)
2.0 x 5 = 10.0	7.5	2.5	5.0	0.0
2.0 x 5 = 10.0	7.5	5.0	5.0	2.5
1.0 x 14 = 14.0	28.0	0.0	0.0	14.0
0.5 x 5 = 2.5	7.5	0.0	0.0	5.0
1.0 x 5 = 5.0	7.5	2.5	2.5	5.0
1.5 x 14 = 21.0	14.0	14.0	7.0	7.0
0.5 x 5 = 2.5	5.0	0.0	0.0	2.5
2.0 x 5 = 10.0	12.5	5.0	2.5	7.5
0.0 x 14 = 0.0	0.0	0.0	0.0	0.0

INFLOW		OUTFLOW		
A-I (in.)	B-I (in.)	A-01 (in.)	A-0 ₂ (in.)	B-0 (in.)
0.0 x 5 = 0.0	0.0	0.0	0.0	0.0
0.0 x 5 = 0.0	0.0	0.0	0.0	0.0
0.5 x 14 = 7.0	0.0	0.0	0.0	0.0
0.0 x 5 = 0.0	12.5	0.0	0.0	7.5
0.5 x 5 = 2.5	5.0	0.0	0.0	2.5
2.0 x 14 = 28.0	14.0	14.0	7.0	7.0
0.5 x 5 = 2.5	5.0	0.0	0.0	2.5
1.0 x 5 = 5.0	5.0	2.5	0.0	2.5
1.0 x 14 = 14.0	14.0	7.0	0.0	7.0
2.0 x 5 = 10.0	5.0	5.0	2.5	2.5
0.5 x 5 = 2.5	2.5	0.0	0.0	0.0
0.5 x 14 = 7.0	0.0	0.0	0.0	0.0
153.5	152.5	57.5	31.5	76.0

By dividing these sums by the number of hours in one week, the quotients obtained are:

$$0.91 \quad 0.91 \quad 0.34 \quad 0.19 \quad 0.45$$

With the use of chart 1, these hourly values were converted into

$$2.1 \quad 2.1 \quad 0.8 \quad 0.4 \quad 1.1 \text{ li./sec.}$$

If the flow of 1 liter/second was continuous for one week, the water would cover a hectare of the paddy to a depth of

$$\frac{1 \times 60 \times 60 \times 24 \times 7 \times 10}{10,000 \times 100 \times 2.54} = 2.38 \text{ inches.}$$

Since the combined area of plots A and B was 13,477 sq. m., the same flow of 1 liter a second would cover these plots to a depth of

$$\frac{2.38 \times 10,000}{13,477} = 1.77 \text{ inches.}$$

Hence, the inflow and the outflow were, respectively:

$$\begin{aligned} 4.2 \times 1.77 &= 7.43 \text{ inches (18.9 cm.) and} \\ 2.3 \times 1.77 &= 4.07 \text{ inches (40.3 cm.).} \end{aligned}$$

Computation of the rainfall. The week's rainfall amounted to a total of

0.000
0.000
0.660
0.000
0.022
0.165
0.055
0.902 inch (2.29 cm.)

Computation of the total water. The inflow added to the rainfall gave the total water that entered the field, which was 7.43 of $0.902 = 8.33$ inches (21.1 cm.)

Computation of the total evaporation. As the evaporimeter was open, it lost water through evaporation but collected water from the rainfall. Therefore, the readings of the instrument represented the difference between the evaporation and the rainfall. When the evaporation exceeded the rainfall, the reading was positive; when the rainfall was more than the evaporation, the difference became negative. In the latter case, the evaporimeter actually gained water. The weekly evaporation from the exposed water surface was obtained by adding algebraically the evaporimeter reading and the rainfall as follows:

EVAPORIMETER READING (in.)		RAINFALL (in.)		EVAPORATION FROM FREE WATER EXPOSURE (in.)
0.286	+	0.000	=	0.286
0.357	+	0.000	=	0.357
-0.461	+	0.660	=	0.199
0.357	+	0.000	=	0.357
0.185	+	0.022	=	0.207
0.000	+	0.165	=	0.165
0.297	+	0.055	=	0.352
				1.923 in. (4.9 cm.)

Table 4 shows that the ratio of the total evaporation to the evaporation from free water surface exposed was 1.0. Therefore, the total evaporation for the 5th week was

$$1.923 \times 1.0 = 1.923 \text{ inches (4.9 cm.)}$$

Computation of the percolation. The results of the percolation experiment gave the percolation for the week as 0.525 inch (1.3 cm.)

Computation of the net water requirement. The total evaporation plus the percolation gave the net water requirement as follows:

$$1.92 + 0.525 = 2.44 \text{ inches (6.2 cm.)}$$

Computation of the net duty. The net duty was obtained by subtracting the rainfall from the net water requirement, thus:

$$2.44 - 0.902 = 1.54 \text{ inches (3.9 cm.)}$$

RESULTS AND DISCUSSION

The weekly computations of the results are shown in table 5, and presented graphically in charts 2, 3, 4, 5, and 6.

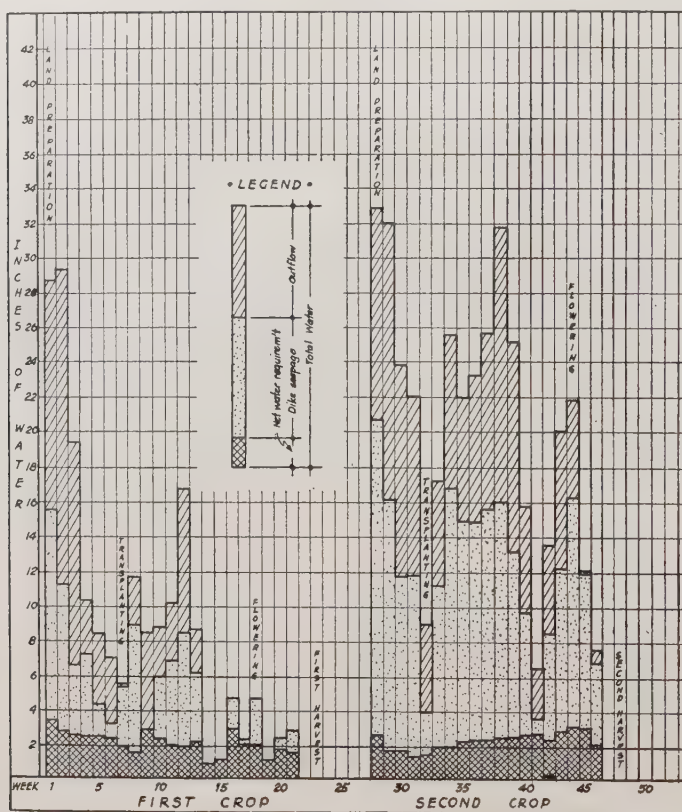


Chart 2.—The weekly outflow, dike seepage, net water requirement, and total water.

The results of the experiments corollary to the field tests, and of the weather observations made from May 21 to June 11, 1947, showed that the water evaporated from tanks with mud and from tanks with water amounted respectively to 21,680 and 21,456 cc., with a ratio of $\frac{21,680}{21,456} = 1.01$ or 1.

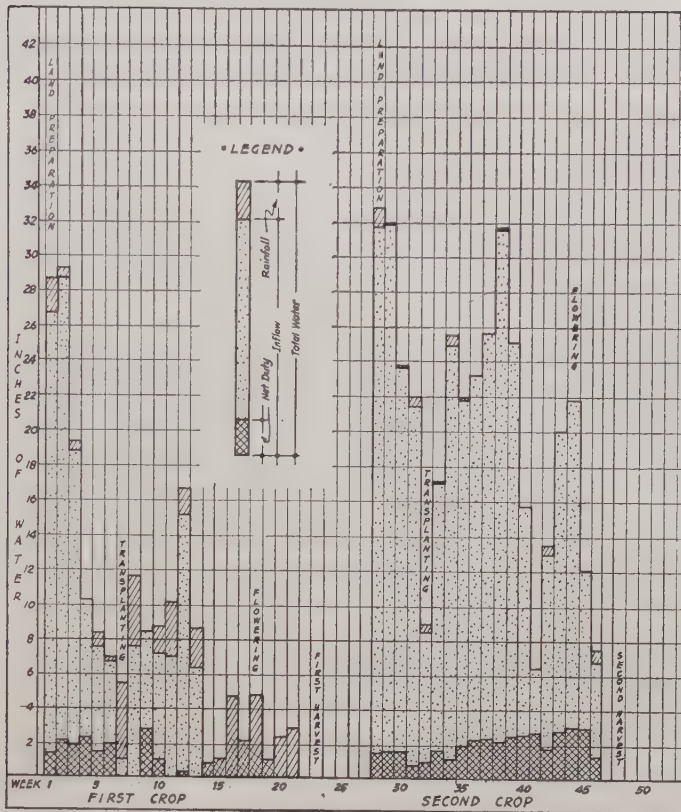


Chart 3.—The weekly rainfall, inflow, total water, and net duty.

Observations made during the four weeks from May 11 to June 11, 1947, of the total evaporation and evaporation from exposed free water surface yielded the following results:

WEEK	CROP STAGE	TOTAL EVA- PORATION (cc.)	EVAPORATION FROM FREE WATER EXPOSURE (cc.)	RATIO	REMARKS
1	Flowering	23,850	12,600	1.90	—
2	Setting	12,330	7,400	1.67	—
3	Maturing	8,400	6,770	1.24	—
4	Maturing	—	—	—	Soil dried

In the first experiment, the ratio was observed to be highest at about the flowering stage of the plant. Since the period between transplanting and flowering was not covered by the experiment, the ratio was estimated by assuming a straightline variation from the value obtained at transplanting week (obtained from the evaporation of water from mud and evaporation from water) to the maximum

value obtained at flowering week. This assumption was an approximation of the actual variation, based on the fact that the transpiration rate is affected largely by the rate of growth of the plant,

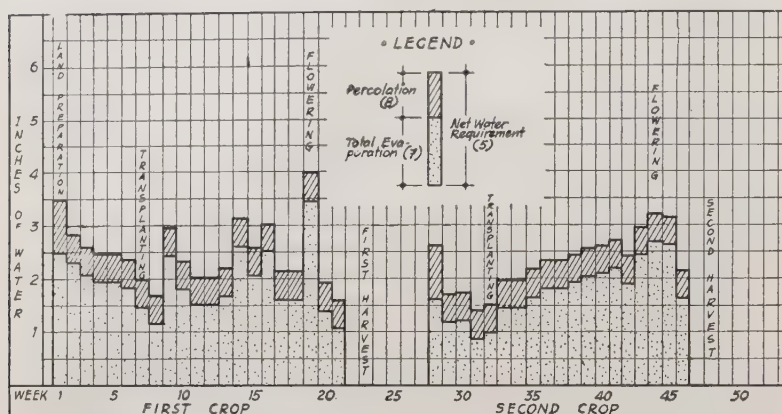


Chart 4.—The weekly total evaporation, percolation, and net water requirement.

which rate in turn varies approximately in a straight line from zero to a maximum.^e

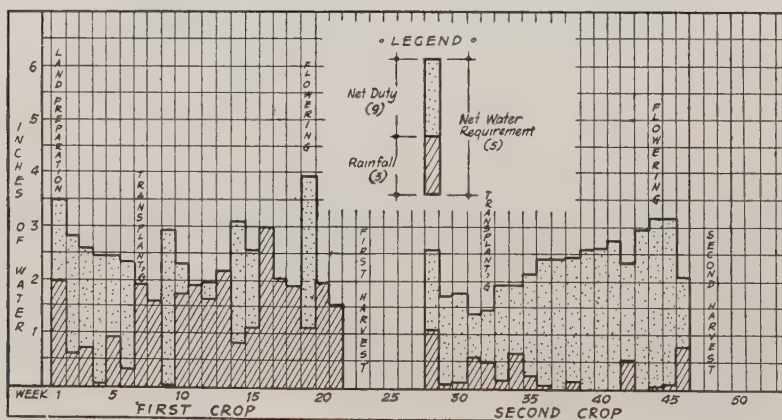


Chart 5.—The weekly net water requirement as provided for by the rainfall and the net duty irrigation water.

The results of observations from June 5, 1947, to June 14, 1947, on the rate of downward percolation were as follows:

^e The rate growth varies in a sigmoid curve, with a slope of zero at the origin and at the maximum point.

DEPTH OF WATER (cm.)	PERCOLATION RATE (cm./week)	PERCOLATION RATE (in./week)
10	1.342	0.528
5	1.322	0.520
3	1.337	0.526
Mean	1.333	0.525

These values show that the rate of downward percolation was very slow and practically unaffected by changes in the depth of water standing in the paddies. The results of the monthly observations on the weather are given in table 6.

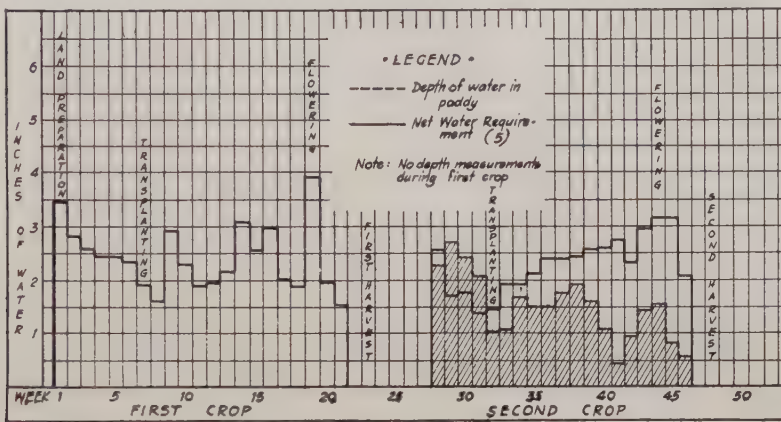


Chart 6.—The weekly mean depth of water in paddies compared with the net water requirement.

The maximum values of the net duty of the irrigation water for the wet-season and the dry-season crops studied were 2.85 inches (7.23 cm.) during the 9th week, and 3.18 inches (8.1 cm.) during the 44th week (table 3). These values correspond to 1.2 and 1.34 liters/second/hectare, which are within the range of 0.75 to 1.5 liters/second/hectare used by the Bureau of Public Works in its design of irrigation systems.

As shown in table 5, the total net duty of water for the wet-season crop was 21.81 inches (55.4 cm.) and for the dry-season crop, 39.14 inches (99.4 cm.). Owing to a delay in the land preparation for the first crop, the irrigation period for the wet-season crop extended through 21 weeks, while that for the dry-season crop lasted only 19 weeks. Considering only the 17-week period between transplanting and maturity of the two crops, the total net duty for the two crops amounted to 10.27 inches (26.1 cm.) and 33.52 inches (85.1 cm.), respectively. As was expected, the wet-season crop required much less irrigation water than the dry-season crop. Chambliss (1920) found that under prairie conditions in the United States, a good yield of rice requires from 20 to 30 inches (51 to 76 cm.) of irrigation water plus 12 to 20 inches (30 to 51 cm.) of rainfall.

Etcheverry and Harding (1933) found that under fair-weather conditions in California, 60 inches (152 cm.) of water is sufficient to mature a crop on clay or adobe soil with good irrigation practice. Often 72 to 96 inches (183 to 244 cm.) is actually used where the soil is more porous or where the levees leak.

The two crops studied by the writers needed a total net water requirement of 50.8 inches (129.0 cm.) and 44.5 inches (113.0 cm.), respectively (table 3), showing that the wet-season crop used more water than the dry-season crop. This difference may be accounted for by the extra length of the land preparation for the first crop. Considering only the period from transplanting to maturity, the total net water requirements were 34.6 inches (87.8 cm.) and 36.8 inches (93.4 cm.), respectively. The dry-season crop used much more water for a shorter period of growth (120 days as against 122 days for the wet-season crop) probably on account of the greater evaporation losses during the hot dry season.

Of the total water of 194.16 inches (493.2 cm.) of irrigation water during the first crop (table 3), only 21.81 inches (55.4 cm.) or 11.23 per cent were utilized to supply the net duty of irrigation water. The other 172.35 inches (437.8 cm.) passed out unused into the next field. During the second crop, a total of 387.57 inches (984.4 cm.) of water flowed into the field, of which only 39.14 inches (99.4 cm.) or 10.1 per cent was used. As shown by these figures, a large flow of excess water constantly passed through the paddies.

The total dike seepage (table 5) for the two crops reached 68.81 inches (174.8 cm.) and 189.42 inches (481.1 cm.), respectively. The field tested had its intake openings at a major supply canal; hence, the dikes at the intake end of the field were more substantially built than those at the discharge end. Very little water seeped into the field through the dikes at the intake end, while much more seeped out at the discharge end. The net effect, including the seepage through the dikes at the sides, made up the "loss" or dike seepage.

During the first crop, heavy rains on the mountains swelled the San Juan river, the source of the irrigation system, overflowing the canals and flooding the field. To avoid damage to the canal system and to prevent the plants from being washed away, the main head-gates to the system were closed. Since the rainfall on the field was not enough to supply the net water requirement, which was further increased by the drying action of strong winds, the paddies lacked water in the middle of the rainy season. The condition which affected the experiment adversely occurred during the 6th, 9th, 14th, and 15th week.

The average depth of water for the dry-season crop was 3.8 cm. or 1.5 inches. Gordon (1929), in his study of the depth of irrigation water for the Guinangang variety of rice in Calauan, Laguna, recorded an average of 10.1 cm. or 4.0 inches. The discrepancy between Gordon's figures and the writers' may have been due more to

a difference in the determination of the zero water level than to a difference in irrigation practice. Besides, the depth of water standing in the paddies is not a quantitative measure of the water requirement of the crop but only of the watertightness and height of the enclosing dikes.

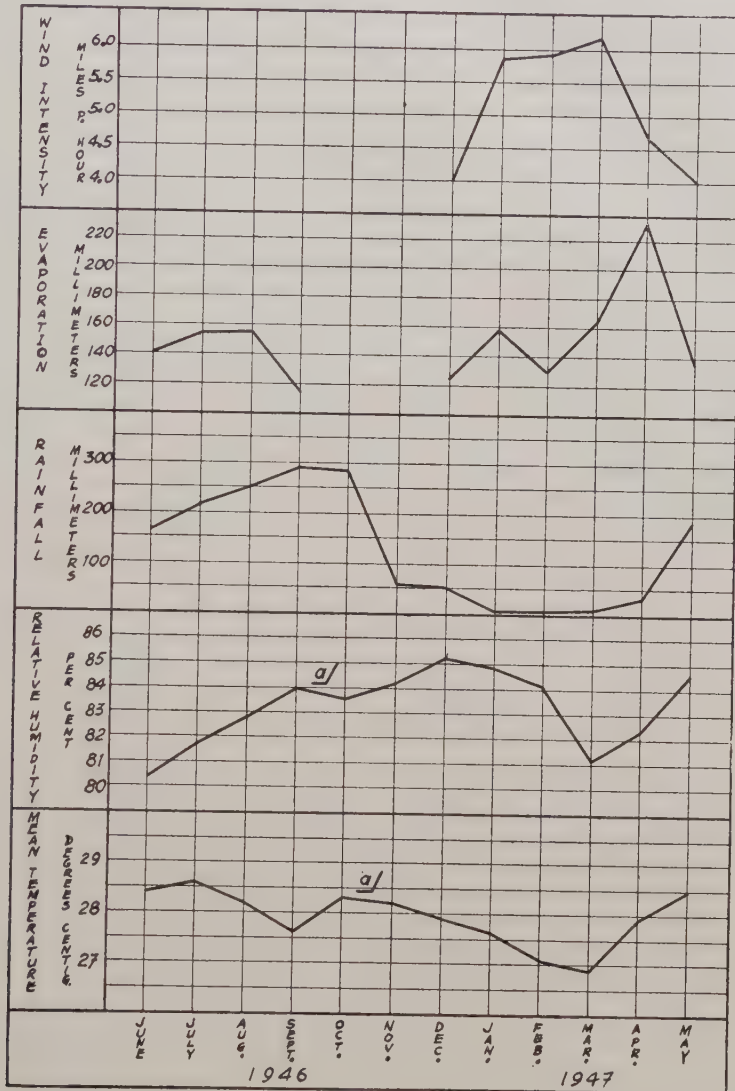


Chart 7.—Weather data gathered from the field in Calamba, Laguna, during the period of the study; (a) average of three readings a day at 7:00 a.m., 12:00 n., and 5:00 p.m.

A comparison of the evaporation from a mud surface with the corresponding evaporation from an exposed free water surface revealed that, on the average, the rates of evaporation from the two surfaces were about equal, provided the mud was kept saturated. Actually, however, the ratio of the first to the second fluctuated between a maximum of 1.5 during the hot noon hours when the mud surface became much hotter than that of the water, to a minimum of 0.7 during the night, when the temperature was low. Also, towards morning the mud surface cooled to the dew point and gained water by condensation.⁷ On the other hand, the water surface seldom, if ever, cooled to this temperature.

The rate of downward percolation was found to have a constant value of 0.525 of an inch (1.3 cm.) in a week. Referring to the soil-profile diagram (fig. 2), the 15 inch (38 cm.) layer of surface soil is shown to be underlaid with adobe stone to a depth of 39 feet (12 m.) below which lay the water-bearing sand stratum and the water table. Under the action of the continuous working and stirring of the mud surface, the pores in the stone may have become clogged with fine soil particles, forming an almost watertight seal. This may have accounted for the extremely low value of percolation. Moreover, the resistance offered to the passage of water by 39 feet of almost impermeable stone material is so great that the effect of the slight hydrostatic pressure of the water standing in the paddies is insignificant. Hence, percolation in this case may be considered as affected entirely by capillarity. The experiment showed that the rate of downward percolation was independent of the depth of water in the paddies. This result is in accordance with the results of Wright's⁸ experiments at Irrigon, Oregon, in 1907, that the rate of downward percolation of water into the soil was very nearly constant for depths of water varying from 12 to 24 inches. The possible effect of temperature changes during the different seasons of the year was not studied in the present experiment.

The yield of the first crop was 100 cavans of palay, and of the second 115, giving the equivalent of 52 and 60 cavans of palay per hectare, respectively. The unexpected inferiority of the regular wet-season crop to the dry-season planting may have been due to the strong winds during the flowering period of the first crop in September, 1946, which resulted in the formation of much empty grain, and also because of the interruption of irrigation during the middle of the growth period of the first or wet-season crop.

⁷ When the humidity of the air is high and the night clear, as much as 0.05 of an inch of water may be added to the soil during a single night by condensation. In a week, this would amount to 0.35 or 0.89 cm. (Thorntwaite and Holzman, 1941).

⁸ WRIGHT, A. E. 1907. Experiments with ditch linings for the prevention of seepage. Thesis, College of Civil Engineering, University of California, Berkeley, Cal.

SUMMARY

1. The maximum values of the net duty of irrigation water in the lowland rice field studied in Calamba, Laguna, were 1.2 and 1.34 li./sec./ha. for the first and second crop, respectively.

2. The total net duty of irrigation water for the period from land preparation to maturity amounted to 55.3 cm. (21.8 in.) for the first crop and 99.4 cm. (39.14 in.) for the second.

3. From transplanting to maturity the corresponding values (total net duty) were 26.1 cm. (10.29 in.) and 85.2 cm. (33.52 in.) for the first and second crops, respectively.

4. The total net water requirements from land preparation to maturity for the two crops were 129.0 cm. (50.8 in.) for the first and 113.0 cm. (44.4 in.) for the second.

5. From transplanting to maturity the corresponding values (total net water requirement) were 87.8 cm. (34.6 in.) and 93.4 cm. (36.8 in.).

6. The rate of downward percolation was very slow and practically unaffected by the slight hydrostatic pressure of the water standing in the paddies. The surface soil being underlaid with 12 meters of adobe stone, the mean weekly percolation was 1.33 cm. (0.525 in.).

7. Of the total water, only 11.23 per cent was utilized to supply the net duty of irrigation water during the first crop and 10.1 per cent during the second.

LITERATURE CITED

- CHAMBLISS, C. E. 1920. *Prairie rice culture in the United States*. U.S. Dept. Agric. Farmers' Bull. 1092: 1-26. Fig. 1-13.
- ETCHEVERRY, B. A., AND S. T. HARDING. 1933. *Irrigation practice and engineering*. 11th ed., Vol. 1, vii + 256 p., 11 fig. New York: McGraw-Hill Book Co., Inc.
- GORDON, A. 1929. A summary of studies on the depths of irrigation water. *Philippine Agriculturist* 17: 579-592.
- TEODORO, A. L., AND E. BATACLAN. 1931. A survey of irrigation practices in the rice industry of Calauan, Laguna. *Philippine Agriculturist* 20: 93-100.
- THORNTON, C. W., AND B. HOLZMAN. 1941. *Evaporation and transpiration*. U.S. Dept. Agric. Yearbook 1941: 545-550.

TABLE 1

Sample of data taken during the first crop: data for the 5th week, June 7-13, 1946

DATE	TEMPERATURE				WATER OVER WEIRS						RAINFALL		EVAPORIMETER READING		REMARKS
	DRY		WET		A-I	A-O ₁	A-O ₂	B-I	B-O	in.	mm.	in.	mm.		
	°C.	°F.	°C.	°F.											
June 1946 7	78	25.5	76	24.5	2.0	0.5	1.0	1.5	0.0	0.000	0.00	0.286	7.3	First harrowing of tract A.	
	92	33.3	82	27.8	2.0	1.0	1.0	1.5	0.5						
	88	31.1	80	26.7	1.0	0.0	0.0	2.0	1.0	0.000	0.00	0.357	9.1	Harrowing con- tinued.	
	78	25.5	76	24.5	0.5	0.0	0.0	1.5	1.0						
8	86	30.0	82	27.8	1.0	0.5	0.5	1.5	1.0						
	78	25.5	80	26.7	1.5	1.0	0.5	1.0	0.5	0.660	16.78	-0.461	-11.7	Finished.	
	78	25.5	76	24.5	0.5	0.0	0.0	1.0	0.5						
	96	30.0	78	25.5	2.0	1.0	0.5	2.5	1.5						
9	82	27.8	76	24.5	0.0	0.0	0.0	0.0	0.0	0.000	0.00	0.357	9.1	First harrowing of tract B.	
	76	24.5	74	23.3	0.0	0.0	0.0	0.0	0.0						
	94	34.4	84	28.9	0.0	0.0	0.0	0.0	0.0						
	88	31.1	80	26.7	0.5	0.0	0.0	0.0	0.0	0.022	0.55	0.185	4.7	Harrowing con- tinued; 2 ca- vans of seed immersed in water.	
10	78	25.5	76	24.5	0.0	0.0	0.0	2.5	1.5						
	90	32.2	82	27.8	5.0	0.0	0.0	1.0	0.5						
	88	31.1	82	27.8	2.0	1.0	0.5	1.0	0.5	0.165	4.19	0.000	0.0	Harrowing con- tinued.	
	76	24.5	74	23.3	0.5	0.0	0.0	1.0	0.5						
11	92	33.3	82	27.8	1.0	0.5	0.0	1.0	0.5						
	84	28.9	78	25.5	1.0	0.5	0.0	1.0	0.5	0.055	1.40	0.297	7.5		
	78	25.5	76	24.5	2.0	1.0	0.5	1.0	0.5						
	94	34.4	82	27.8	0.5	0.0	0.0	0.5	0.0						
12	90	32.2	80	26.7	0.5	0.0	0.0	0.0	0.0						
	78	25.5	76	24.5	2.0	1.0	0.5	1.0	0.5						
	94	34.4	82	27.8	0.5	0.0	0.0	0.5	0.0						
	90	32.2	80	26.7	0.5	0.0	0.0	0.0	0.0						
13															

TABLE

Sample of data taken during the second crop:

DATE	TEMPERATURE				WATER OVER WEIRS							
	DRY		WET		A-I	A-O ₁	A-O ₂	B-I	B-O	C-I	C-O	D-I
	°C.	°F.	°C.	°F.	in.	in.	in.	in.	in.	in.	in.	in.
1946 Nov.												
22	78	25.5	76	24.5	2.0	0.5	0.5	4.0	1.0	2.0	1.0	3.0
	88	31.1	82	27.8	1.0	0.5	0.0	2.0	0.5	1.0	0.5	0.5
	80	26.7	78	25.5	0.5	0.0	0.0	1.0	0.0	0.5	0.0	0.0
23	78	25.5	76	24.5	1.0	0.5	0.0	3.0	1.0	1.0	0.0	0.5
	88	31.1	82	27.8	5.0	2.0	1.5	0.5	0.0	2.0	1.0	2.0
	80	26.7	78	25.5	5.0	2.0	1.5	0.5	0.0	2.0	1.0	2.0
24	78	25.5	76	24.5	5.0	2.0	1.5	1.0	0.0	2.0	1.0	2.0
	88	31.1	82	27.8	2.0	1.0	0.0	2.0	0.5	2.0	1.0	2.0
	80	26.7	78	25.5	2.0	1.0	0.0	3.0	1.0	2.0	1.0	1.0
25	78	25.5	76	24.5	0.0	0.0	0.0	4.0	2.0	2.0	1.0	2.0
	88	31.1	80	26.7	5.0	2.0	1.0	5.0	2.0	2.0	2.0	2.5
	82	27.8	80	26.7	5.0	2.0	1.0	5.0	2.0	2.0	1.0	2.0
26	78	25.5	76	24.5	4.0	2.0	0.5	4.0	2.0	2.0	1.0	2.0
	88	31.1	80	26.7	4.0	2.0	1.0	4.0	2.0	2.0	1.0	2.0
	80	26.7	78	25.5	4.0	2.0	1.0	4.0	2.0	2.0	1.0	2.0
27	78	25.5	76	24.5	4.0	2.0	1.0	4.0	2.0	2.0	1.0	2.0
	88	31.1	86	30.0	4.0	2.0	1.0	4.0	2.0	2.0	1.5	2.0
	78	25.5	76	24.5	4.0	2.0	1.5	4.0	1.5	2.0	1.0	2.0
28	78	25.5	76	24.5	4.0	2.0	1.0	5.0	2.0	2.0	1.0	2.5
	88	31.1	80	26.7	5.0	2.0	2.0	4.0	2.0	2.0	1.0	2.5
	82	27.8	78	25.5	5.0	2.0	2.0	4.0	2.0	2.0	1.0	2.0

for the 29th week, Nov. 22-28, 1946

	RAINFALL		DEPTH OF WATER				ANEMOMETER MILEAGE	WIND DIRECTION	REMARKS
	in.	mm.	A cm.	B cm.	C cm.	D cm.			
5 0 0	0.000	0.0	6 4	8 6	5 4	7 3	550.45 610.58 640.82	N E NE	First plowing finished.
0 0 0	0.000	0.0	3 10 10	4 3 3	2 6 5	2 7 7	720.91 780.58 840.32	NE NE NE	
0 0 0	0.000	0.0	10 6 6	3 5 7	5 5 6	6 6 5	890.20 930.39 980.10	E E NE	
0 0 5	0.000	0.0	0 10 10	8 11 10	7 7 6	7 6 6	40.20 70.59 90.22	NW E E	First harrowing of tracts B, C, and D.
0 0 0	0.000	0.0	9 9 9	10 10 10	6 6 6	6 6 7	170.09 190.44 200.53	E SE NE	
0 0 0	0.111	29.7	10 10 12	8 11 10	7 7 6	6 7 7	250.58 310.78 410.90	NE NE NE	
5 5 0	0.000	0.0	10 11 11	11 10 10	7 7 7	9 9 7	470.58 500.63 620.70	SE NE E	First harrowing finished.

TABLE 3
Weir discharge

WATER HEAD ON WEIR	DISCHARGE		
	THEORETICAL ^a	ACTUAL ^b	CORRECTED ^c
<i>in.</i>	<i>1./sec.</i>	<i>1./sec.</i>	<i>1./sec.</i>
1.0	1.9	2.6	2.5
1.5	—	—	3.7
2.0	4.8	5.4	5.1
2.5	—	—	6.4
3.0	8.0	—	7.8
3.3	—	8.3	8.8
3.4	—	9.1	9.1
3.5	—	—	9.7
4.0	13.9	—	11.8
4.5	—	13.7	14.0

^a Obtained by the Francis formula corrected for two end contractions.

$$Q = 3.33 L H^{3/2}$$

where $L = L - .2H$
and L and H are in feet

^b Computed from actual data.

^c Obtained from the smoothed *discharge curve* in *chart 1*.

TABLE 4

*The approximate ratio of the total evaporation
to the evaporation from free water exposure*

WEEK	DATE	RATIO	CROP STAGE
	1946		
1	May 10	1.0	First crop, land preparation
2	17	1.0	"
3	24	1.0	"
4	31	1.0	"
5	June 7	1.0	"
6	14	1.0	"
7	21	1.0	Transplanting
8	28	1.075	Growth
9	July 5	1.150	"
10	12	1.225	"
11	19	1.300	"
12	26	1.375	"
13	Aug. 2	1.450	"
14	9	1.525	"
15	18	1.600	"
16	23	1.675	"
17	30	1.750	"
18	Sept. 6	1.825	"
19	13	1.900	Flowering
20	20	1.67	Maturing
21	27	1.24	"
22	Oct. 4	—	" ; end of irrigation
23	11	—	Harvesting
24	18		
25	25		
26	Nov. 1		
27	8		
28	15	1.0	Second crop, land preparation
29	22	1.0	"
30	29	1.0	"
31	Dec. 6	1.0	"
32	13	1.0	Transplanting
33	20	1.075	Growth
34	27	1.150	"
35	1947 Jan. 3	1.225	"
36	10	1.300	"
37	17	1.375	"
38	24	1.450	"
39	31	1.525	"
40	Feb. 7	1.600	"
41	14	1.675	"
42	21	1.750	"
43	28	1.825	"
44	Mar. 7	1.900	Flowering
45	14	1.67	Maturing
46	21	1.24	"
47	28	—	" ; end of irrigation
48	Apr. 4	—	Harvesting
49	11		
50	18		
51	23		
52	May 2		

WEEK NUMBER	DATE	TOTAL WATER		INFLOW		RAINFALL		OUTFLOW		NET WATER REQUIREMENT	
		(in.)	(cm.)	(in.)	(cm.)	(in.)	(cm.)	(in.)	(cm.)	(in.)	(cm.)
1	1946 May 10	28.66	72.8	25.68	67.8	1.98	5.0	13.40	34.0	3.46	8.8
2	" 17	29.30	74.4	28.67	72.8	0.63	1.6	18.05	45.8	2.84	7.2
3	" 24	19.47	49.4	18.76	47.7	0.71	1.8	12.92	32.8	2.44	6.7
4	" 31	10.34	26.3	10.27	26.1	0.07	0.2	3.19	8.1	2.42	6.1
5	June 7	8.33	21.1	7.43	18.9	0.90	2.3	4.07	10.3	2.44	6.2
6	" 14	7.05	17.9	6.72	17.1	0.33	0.8	3.89	9.9	2.36	6.0
7	" 21	5.72	14.5	1.42	3.6	4.30	10.9	0.18	0.5	1.90	4.8
8	" 28	11.84	30.1	7.78	19.8	4.06	10.3	2.83	7.2	1.60	4.1
9	July 5	8.50	21.6	8.49	21.6	0.01	0.0	5.48	14.0	2.86	7.3
10	" 12	8.81	22.4	7.08	18.0	1.73	4.4	2.73	6.9	2.30	5.8
11	" 19	10.21	25.9	7.08	18.0	3.13	7.9	3.37	8.6	1.86	4.7
12	" 26	16.87	42.8	15.22	38.7	1.65	4.2	8.32	21.1	1.94	4.9
13	Aug. 2	8.79	22.3	6.57	16.7	2.22	5.4	2.68	6.8	2.20	5.6
14	" 9	0.81	2.1	0.00	0.00	0.81	2.1	0.00	0.0	3.14	8.0
15	" 16	1.13	2.9	0.00	0.00	1.13	2.9	0.00	0.0	2.58	6.6
16	" 23	4.80	12.2	0.00	0.00	4.80	12.2	0.00	0.0	3.00	7.6
17	" 30	2.25	5.7	0.00	0.00	2.25	5.7	0.00	0.0	2.04	5.2
18	Sept. 6	4.78	12.1	0.00	0.00	4.78	12.2	0.00	0.0	1.84	4.7
19	" 13	1.10	2.8	0.00	0.00	1.10	2.8	0.00	0.0	3.88	4.6
20	" 20	2.41	6.1	0.00	0.00	2.41	6.1	0.00	0.0	1.98	5.0
21	" 27	2.99	7.6	0.00	0.00	2.99	7.6	0.00	0.0	1.52	3.9
T O T A L S		194.16	493.2	152.17	386.5	41.99	106.7	81.11	206.0	50.80	129.0
22	Oct. 4					0.34	0.9				
23	" 11					1.60	4.1				
24	" 18					0.52	1.3				
25	" 25					7.38	18.8				
26	Nov. 1					0.51	1.3				
27	" 8					0.55	1.4				
28	Nov. 15	32.98	83.7	31.86	80.9	1.12	2.8	12.18	30.9	2.62	6.7
29	" 22	32.09	81.5	31.98	81.2	0.11	0.3	15.87	40.3	1.78	4.5
30	" 29	23.89	60.7	23.74	60.3	0.15	0.4	12.18	30.4	1.86	4.7
31	Dec. 6	22.04	56.0	21.40	54.3	0.64	1.6	10.33	26.3	1.38	3.5
32	" 13	9.09	23.1	8.61	21.9	0.48	1.2	5.04	12.8	1.48	3.8
33	" 20	17.40	44.2	17.22	43.7	0.18	0.5	6.03	15.3	1.94	4.9
34	" 27	25.79	65.5	25.09	63.7	0.70	1.8	8.98	22.8	1.92	4.9
35	1947 Jan. 3	22.01	55.9	21.77	55.3	0.24	0.6	7.13	18.1	2.22	5.6
36	" 10	21.35	54.2	21.28	54.1	0.07	0.1	8.61	21.9	2.40	6.1
37	" 17	25.71	65.3	25.71	65.3	0.00	0.0	10.21	25.9	2.42	6.1
38	" 24	31.88	81.0	31.73	80.5	0.15	0.4	15.87	40.3	2.46	6.2
39	" 31	25.22	64.1	25.22	64.0	0.00	0.0	12.05	30.6	2.64	6.7
40	Feb. 7	15.87	40.3	15.87	40.3	0.00	0.0	6.15	15.6	2.66	6.8
41	" 10	6.64	16.9	6.64	16.9	0.00	0.0	2.95	7.5	2.76	7.0
42	" 21	13.74	34.9	13.16	33.4	0.58	1.5	5.17	13.1	2.38	6.0
43	" 28	20.05	50.9	20.05	50.9	0.00	0.0	7.99	20.3	2.96	7.5
44	Mar. 7	21.93	55.7	21.89	55.7	0.04	0.1	5.78	14.7	3.22	8.2
45	" 14	12.05	30.9	12.05	30.6	0.10	0.3	0.25	0.6	3.22	8.2
46	" 21	7.74	19.7	6.94	17.6	0.80	2.0	0.88	2.2	2.18	5.5
T O T A L S		387.57	984.4	382.21	470.8	5.36	13.6	153.65	390.3	44.50	113.0
47	Mar. 28					0.00	0.0				
48	April 4					0.07	0.2				
49	" 11					0.00	0.0				
50	" 18					0.00	0.0				
51	" 25					0.20	0.5				
52	May 2					0.13	0.3				

^a An extra inch of water was estimated

TABLE 5

the irrigation water:

ST CROP

DIKE SEEPAGE		TOTAL EVAPORATION		PERCOLATION		NET DUTY		DEPTH OF WATER		REMARKS
(in.)	(cm.)	(in.)	(cm.)	(in.)	(cm.)	(in.)	(cm.)	(in.)	(cm.)	
11.80	30.0	1.93	4.9	1.535	3.9	1.48	3.8			Land preparation: start of irrigation
8.41	21.4	2.31	5.9	0.525	1.3	2.21	5.6			
3.91	9.9	2.11	5.4	0.525	1.3	1.93	4.9			
4.73	12.0	1.89	4.8	0.525	1.3	2.35	6.0			
1.82	4.6	1.92	4.9	0.525	1.3	1.54	3.9			
0.80	2.0	1.83	4.6	0.525	1.3	2.03	5.2			Transplanting
3.64	9.2	1.37	3.5	0.525	1.3	0.00	0.0			
7.41	18.8	1.07	2.7	0.525	1.3	0.00	0.0			
0.16	0.4	2.33	5.9	0.525	1.3	2.85	7.3			
3.78	9.6	1.78	4.5	0.525	1.3	0.57	1.4			
4.98	12.7	1.33	3.4	0.525	1.3	0.00	0.0			Canal gates closed
6.61	16.8	1.42	3.6	0.525	1.3	0.29	0.7			
3.91	9.9	1.67	1.2	0.525	1.3	0.00	0.0			
0.00	0.0	2.61	6.6	0.525	1.3	2.33	5.9			
0.00	0.0	2.06	5.2	0.525	1.3	1.45	3.7			
1.80	4.6	2.48	6.3	0.525	1.3	0.00	0.0			Flowering
0.21	0.5	1.52	3.9	0.525	1.3	0.00	0.0			
2.94	7.5	1.31	3.3	0.525	1.3	0.00	0.0			
0.00	0.0	3.36	8.5	0.525	1.3	2.78	7.1			
0.43	1.1	1.45	3.7	0.525	1.3	0.00	0.0			
1.47	3.4	0.99	2.5	0.525	1.3	0.00	0.0			Field drained
68.81	174.8	38.74	48.3	12.025	30.6	21.81	55.3			
										Harvest

ND CROP

18.18	46.2	1.10	2.8	1.525 ^a	3.9	1.50	3.8	2.28	5.8	Land preparation: start of irrigation
14.44	36.7	1.25	3.2	0.525	1.3	1.67	4.2	2.71	6.9	
9.85	25.0	1.34	3.4	0.525	1.3	1.71	4.3	2.44	6.2	
10.33	26.3	0.86	2.2	0.525	1.3	0.74	1.9	2.16	5.5	
2.57	6.5	0.96	2.4	0.525	1.3	1.00	2.5	1.02	2.6	
9.43	23.9	1.42	3.6	0.525	1.3	1.76	4.5	1.14	2.9	Transplanting
14.89	37.8	1.39	3.5	0.525	1.3	1.22	3.1	1.73	4.4	
12.66	32.1	1.69	4.5	0.525	1.3	1.98	5.0	1.50	3.8	
10.34	26.3	1.88	4.8	0.525	1.3	2.33	5.9	1.50	3.8	
13.08	33.2	1.90	4.8	0.525	1.3	2.42	6.1	1.77	4.5	Flowering
13.55	34.4	1.94	4.9	0.525	1.3	2.31	5.9	1.89	4.8	
10.53	26.8	2.11	5.4	0.525	1.3	2.64	6.7	1.65	4.2	
8.06	17.9	2.13	5.4	0.525	1.3	2.66	6.8	1.14	2.9	
0.93	2.4	2.23	5.7	0.525	1.3	2.76	7.0	0.47	1.2	
6.19	15.7	1.86	4.7	0.525	1.3	1.80	4.6	0.91	2.3	Field drained
9.10	23.1	2.43	6.8	0.525	1.3	2.96	7.5	1.42	3.6	
12.93	32.8	2.70	6.9	0.525	1.3	3.18	8.1	1.57	4.0	
8.68	22.1	2.70	6.9	0.525	1.3	3.12	7.9	0.79	2.0	
4.68	11.9	1.66	4.2	0.525	1.3	1.38	3.5	0.59	1.5	
189.42	481.1	33.55	85.2	10.975	27.8	39.14	99.4	28.68	72.9	
										Harvest

be required to soak the soil initially.

TABLE 6

*Weather data gathered from the field in Calamba, Laguna
during the period of the study*

DATE	MEAN TEMPERATURE ^a		RELATIVE HUMIDITY ^a	RAINFALL		EVAPORATION FROM FREE WATER EXPOSURE		WIND INTENSITY
	°F.	°C.				in.	cm.	
1946			per cent	in.	cm.	in.	cm.	m.p.h.
June	83.2	28.4	80.3	6.97	168	5.56	141	—
July	83.4	28.6	81.7	8.72	221	6.07	154	—
Aug.	82.8	28.2	82.8	9.89	251	6.09	155	—
Sept.	82.1	27.8	84.0	11.29	287	4.56	115	—
Oct.	82.9	28.3	83.6	11.20	284	—	—	—
Nov.	82.7	28.2	84.2	2.35	60	—	—	—
Dec.	82.2	27.9	85.2	2.10	53	4.88	124	4.0
1947								
Jan.	81.8	27.7	84.9	0.46	12	6.23	158	5.8
Feb.	80.7	27.1	84.1	0.58	15	5.10	130	5.9
Mar.	80.4	26.9	81.2	0.95	24	6.49	165	6.2
Apr.	82.2	27.9	82.3	2.64	67	9.28	236	4.7
May	83.3	28.5	84.7	7.32	186	5.33	135	4.0
MEAN	82.4	28.0	83.2	5.36	136	5.94	151	5.1

^a Averages of three readings a day taken at 7:00 a.m., 12:00 n., and 5:00 p.m.

EDUCATIONAL AND OCCUPATIONAL PURSUITS OF FORMER STUDENTS IN THE BATANGAS AND ILOCOS NORTE HIGH SCHOOLS¹

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If the high school is to become an effective social agency, it must serve the needs of the student population. Its curriculum must be formulated with the aim of preparing the youth for their future lifework. As a guide in the formulation of an effective curriculum, it is necessary to know the activities of former high-school students, particularly their educational and occupational pursuits.

Review of literature

Several studies have been conducted concerning students in the secondary school, but very few investigations have been made on the educational and occupational pursuits of former high-school students.

Sacay², in a study of 1,151 high-school seniors in nine academic high schools, reported that 51.1 per cent of the fathers of these students were farmers and 12.8 per cent, merchants. Of the students intending to go to college, 15.1 per cent selected the course in agriculture.

Sacay, Meesukh, and Shribhibhadhna in 1948³ made a comparative study of the characteristics of 2,551 first-year students enrolled in 36 agricultural, rural, and academic high schools. They reported that the academic high-school students were drawn largely from the town population, and only 35.1 per cent were children of farmers. About 21.4 per cent of the students selected farming as their future occupation.

The principal object of the present study was to determine (a) the characteristics of former students of the Batangas and Ilocos Norte high schools, (b) persistence in school and educational attainment, and (c) occupational pursuits.

MATERIALS AND METHODS

The subjects of this study were 1,028 former students who enrolled in the first year in the Batangas and Ilocos Norte high schools in 1935, 1936, and 1937.

¹ Experiment Station Contribution No. 1501. Read by Mr. Saguiguit before the Los Baños Biological Club on February 20, 1948.

² SACAY, F. M. 1938. Vocational education studies: I. Occupational background and vocational choice of high-school seniors. *Philippine Agriculturist* 26: 858-869.

³ SACAY, F. M., CHAN MEESUKH, AND PRAVES SHRIBHIBHADHNA. 1948. A comparative study of certain characteristics of first-year students in agricultural, rural, and academic high schools. *Philippine Agriculturist* 31: 305-310.

The school records of the students were examined and desired data were obtained by personal interview with the students. A questionnaire was used in collecting the data. In certain cases, they were secured by correspondence because the students could not be contacted personally.

The investigation was performed in 1946, or nine to eleven years after the students entered the high school.

RESULTS AND DISCUSSION

Sex of students

There was a higher proportion of male than female students. Of the 1,028 students included in the study, 55.3 per cent were male and 44.7 per cent, female.

Age of students

The boys enrolled in the first year were slightly older than the girls. The average age of the male students was 14.1 years; that of the female students, 13.9.

Districts from which students were drawn

A larger number of the students, comprising about 70.1 per cent of the total, were from the town, or *poblacion*. Those living in farm villages comprised 24.6 per cent, and those from fishing barrios, 5.1 per cent.

Occupational groups from which students were drawn

The students were drawn from 69 occupational groups. The largest number of students came from the farming group, which represented 22.4 per cent. The children of merchants comprised 19.4 per cent; laborers, 11.1; teachers, 7.0; clerks, 4.5; landlords, 3.0; government employees, 3.0; fishermen, 2.7; mechanics, 1.7; lawyers, 1.6; and carpenters, 1.2.

Educational attainment

Of the 1,028 students included in the investigation, 9.2 per cent did not reach the second year (table 1). About 82.2 per cent reached the third year and 77.0 per cent, the fourth year. Because of the failure of one student to complete the course, only 76.9 per cent graduated from the high school.

About one third of the high-school graduates did not pursue further education. Only 50.2 per cent of the students that started first-year high school reached college or an institution of junior-college level. Not all these students went beyond the first year, as

only 33.0 per cent reached the second year. A great majority of those who studied two years beyond the high school graduated from the two-year normal course.

Because of the large number who pursued the two-year normal course, there was a sudden drop in the number of students reaching the third year of college education. Only 8.7 per cent of the cases studied reached the third year. A smaller number, comprising 2.4 per cent of students who entered the high school, reached the fourth year. Only about 0.6 per cent of the students who entered the first year of high school graduated from a four-year college. There were, however, students who were still studying at the time of the survey. Computed on the basis of the rate of elimination found for students that have already stopped studying, the percentage reaching fourth year would total 3.6. The percentage of college graduation would reach 1.4.

Sex of students and educational attainment

Of the male students, 75.8 per cent graduated from the high school. Not all graduates pursued higher education, for only 42.7 per cent entered college. About 26.4 per cent reached the second year; 8.4 per cent, the third year; 1.1 per cent, the fourth year; and 0.5 per cent graduated. The percentage of graduation would be about 1.8 if the students still studying in college were considered.

Among the female students, 78.5 per cent graduated from the high school. About 59.6 per cent of the original number entered college, but only 41.1 per cent reached the second year. The percentage in the third year dropped to 8.9 because of the large number of girls who stopped studying after graduating from the two-year normal course. About 4.1 per cent of the girls reached fourth year college, and 0.6 per cent graduated. The percentage of graduation would be about 0.8 if the students still in college were taken into account.

A larger proportion of female students graduated from the high school. The percentage of girls that entered college was also higher than that of the boys, the figures being 59.6 and 42.7 per cent, respectively.

Seventh-grade rating and educational attainment

The seventh-grade rating of the students had some relation with their educational attainment. Among the boys, those who did not graduate from high school had an average rating of 79.0 per cent, while those who reached fourth year college obtained an average rating of 85.7 per cent in the seventh grade. The average rating of those who graduated from high school but did not enter college was 80.4 per cent, while those who entered college but did not reach fourth year obtained an average of 82.7.

Among the girls, a similar relationship was found. Those who did not reach college had an average seventh-grade rating of 80.4 per cent, while the ratings of those who entered college was 82.1 and those who reached fourth year college, 82.4 per cent.

Vocational courses taken in schools of secondary level

Of the 1,028 students included in the investigation, 57.5 per cent reported having taken one or more vocational courses in the high school or in special schools of the secondary level. Among the boys, thirteen vocational courses were reported. The popular courses were the following: automotive mechanics, 24.0 per cent; animal husbandry, 16.7; horticulture, 15.2; agronomy, 14.9; stenography and typewriting, 11.0; and retail merchandising, 9.0.

The girls reported having taken eleven vocational courses. As is to be expected, home economics was the most popular, being reported by 71.5 per cent of the girls who took vocational courses. The other popular courses were stenography and typewriting, 8.8 per cent; retail merchandising, 7.8; hair science, 4.1; and book-keeping, 3.1.

Courses taken in schools of junior-college level

Of the boys included in the study, only 48, or 8.6 per cent, attended schools of the junior-college level. Of the 48, 75 per cent attended a normal school, and 23.0 per cent, a school of arts and trades.

Among the girls, 162, or 35.4 per cent, attended schools of the junior-college level. Of the 162, a big majority, or 96.3 per cent, attended a normal school.

Courses taken in college

The most popular courses taken in college by the boys were engineering, commerce, law, and medicine. About 85.4 per cent of the boys who entered college pursued these courses. The percentage enrolled in each was as follows: engineering, 24.5; commerce, 23.0; law, 20.8; and medicine, 17.1. Only 1.8 per cent took agriculture.

Among the girls, about 91.9 per cent of the number pursued courses in education, pharmacy, nursing, and commerce. The percentage enrolled in each was as follows: education, 51.3; pharmacy, 17.2; nursing, 11.7; and commerce, 11.7.

Occupational pursuits

The former high-school students were engaged in 56 occupations, as may be seen in table 2. Teaching was the leading occupation pursued by former students, particularly by the girls. About 19.1 per cent went into this line of work. Another 13.9 per cent

became housekeepers. This group was entirely composed of girls. About 10.0 per cent engaged in business. Those who were still pursuing further studies comprised 9.4 per cent.

Only 6.3 per cent of the former students engaged in farming. The other occupations in which an appreciable number of former students engaged were as follows: soldier, 6.8 per cent; laborer, 4.6; typist, 4.3; clerk, 3.5; dressmaker, 2.3.

Sex and occupation

There was a difference in the nature of the occupations pursued by the male and the female individuals. In the case of the males, the distribution in the more important occupations was as follows: businessman, 13.7 per cent; student, 12.6; soldier, 12.0; farmer; 11.4; laborer 8.2; teacher, 5.9; typist, 5.1; civilian guard of the U. S. Army, 3.1; driver, 2.1; and mechanic, 1.6.

Among the females, the distribution was as follows: teacher, 35.3 per cent; housekeeper, 30.9; merchant, 7.0; student, 5.6; dressmaker, 5.2; typist, 3.4; salesgirl, 1.9; and nurse, 1.9.

Educational attainment and occupation

The occupation of the males was affected by the educational attainment. Of those who did not graduate from high school, 30.7 per cent engaged in farming. A very much smaller number of those who attained higher education pursued this occupation, the percentage being 8.5 for those who graduated from the high school but did not pursue further studies, and 3.3 for those who entered college. The other principal occupations of those who did not graduate from high school were as follows: merchant, 11.1 per cent; laborer, 11.1; soldier, 8.5; fisherman, 4.3; and driver, 4.3.

In the case of the male students who graduated from the high school but did not continue further studies, the greatest number, 18.2 per cent, engaged in business. The other important occupations were as follows: laborer, 13.0 per cent; soldier, 11.9; farmer, 8.5; clerk, 8.5; typist, 7.3.

Of the group that entered college, 30.1 per cent were still studying; 14.1 per cent were soldiers; 11.3 per cent, teachers; 8.9 per cent, merchants; 5.2 per cent, typists.

It is interesting to note that the proportion that became farmers, laborers, drivers, and fishermen decreased as the educational attainment increased. On the other hand, the proportion that became teachers, typists, and clerks became larger as the education acquired increased.

The influence of education on occupational pursuit was also evident in the case of the female students. Among those who did not graduate, 63.1 per cent became housekeepers; 14.4, merchants; and 11.9, dressmakers. Among those who graduated from the high

school but did not enter college, the principal occupations were the following: housekeeper, 40.2 per cent; teacher, 23.2; merchant, 9.8; salesgirl, 6.1; typist, 4.9; dressmaker, 4.9.

Of the group that entered college, 51.4 per cent became teachers; and 9.4 per cent were still studying. One, forming 4.1 per cent, was a typist. The merchant, the dressmaker, and the nurse made 3.3 per cent each.

These figures show that the proportion of housekeepers, merchants, and dressmakers decreased as the educational attainment advanced. On the other hand, there was an increase in the proportion that became teachers.

Annual income from occupations

The average annual income of the males was ₱1301.47, which was much higher than the ₱964.62 of the females. The median income of both groups was between ₱1000 and ₱1200 a year.

Educational attainment and income

The income was influenced to some extent by the educational attainment. Those who did not graduate from high school earned ₱849.35, while those who graduated from college averaged ₱2300. Those who graduated from high school had an average income of ₱1530.48, or slightly higher than the ₱1441.84 of those who entered college but did not graduate. This higher income of the former group was due to the unusually big income reported by two who were truck operators.

In the case of the females, there was a tendency for the income to increase with the advance in educational attainment. Those who did not graduate from high school earned an average of ₱635.00; those who graduated from high school but did not continue further studies, ₱945.37; those who entered college, ₱1,493.08. There were only three cases of college graduates who had an average income of ₱966.66.

Place of business, marital state, home ownership, home conveniences

Nearly one half, or 49.6 per cent, of the males were pursuing their occupations in their home towns. About a fourth, 22.7 per cent, were in other towns in the province. In the case of the females, a larger percentage, 63.0 per cent, were in their home towns, while 16.3 per cent were pursuing their occupations in other towns in the province.

Only about 26.7 per cent of the males and 33.8 per cent of the females had already married at the time of the survey. The average age on the date of marriage was 21.7 years for males and 20.5 years for females.

Over one half, or 51.9 per cent, of the former students were living in dwellings owned by their parents. Only 28.3 per cent owned the dwellings where they were residing. The remaining 19.8 per cent rented or partly owned their homes.

Slightly over one half, or 54.2 per cent, had running water in their homes and about the same number had electric lights. Only 1.5 per cent were using electric irons, and 0.3 per cent owned refrigerators. A small number, 0.7 per cent, had an ice box. About 10.7 per cent owned a phonograph; 9.5 per cent, a radio; and 4.0 per cent, a piano.

SUMMARY

1. Of the 1,028 former students who enrolled in the Batangas and Ilocos Norte high schools in 1935, 1936, and 1937, 55.3 per cent were male and 44.7 per cent, female.

2. The average age at the time of enrollment was 14.1 years for male and 13.9 years for female students.

3. About 70.1 per cent of the students came from the town or *poblacion*; 24.8 per cent, from farm villages; and 5.1 per cent, from fishing barrios.

4. The parents of the students belonged to 69 occupational groups. The distribution of the most important ones was as follows: farmers, 22.4 per cent; merchants, 19.4; laborers, 11.1; teachers, 7.0; clerks, 4.5; and government employees, 3.0.

5. About 76.9 per cent of the students completed the fourth year of high school. While 50.2 per cent entered college, 33.0 per cent completed two years and only 2.4 per cent of the original number reached the fourth year. If those still studying were taken into consideration, about 3.6 per cent would reach the fourth year and 1.4 per cent would graduate from college.

6. The seventh-grade rating of the students was related to their educational attainment.

7. The percentage enrollment among the students who took vocational courses in the high school was as follows: automotive mechanics, 24.0 per cent; animal husbandry, 16.7; horticulture, 15.2; agronomy, 14.9; stenography and typewriting, 11.0. Among the girls, the most popular vocational courses were home economics, 71.5 per cent; stenography and typewriting, 8.8; and retail merchandising, 7.8.

8. Of the boys who entered schools of the junior-college level, 75 per cent attended a normal school and 23.0 per cent, a school of arts and trades. Of the girls who entered schools of the junior-college level, 96.3 per cent attended a normal school.

9. The male students who entered college took the following courses: engineering, 24.5 per cent; commerce, 23.0; law, 20.8; medicine, 17.1; agriculture, 1.8. Among the girls who entered college, 51.3 per cent studied education; 17.2 per cent, pharmacy; 11.7 per cent, nursing; and 11.7 per cent, commerce.

10. The students who, nine to eleven years ago, entered the first year of high school were found engaged in 56 occupational groups. Among the males, the important ones chosen were those of

businessmen, 13.7 per cent; students, 12.6; soldiers, 12.0; farmers, 11.4; laborers, 8.2; teachers, 5.9; typists, 5.1; and clerks, 5.1. Among the females, the important ones were those of teachers, 35.3 per cent; housekeepers, 30.9; merchants, 7.0; students, 5.6; dressmakers, 5.2; and typists, 3.4.

11. Educational attainment influenced the nature of occupations pursued by male and female individuals and, to some extent, income. The average annual income of the males was ₱1301.47, and of the females, ₱964.62.

12. About 49.6 per cent of the males and 63.0 of the females pursued their occupations in their home towns.

13. Only 26.7 per cent of the males and 33.8 per cent of the females were married at the time of the survey. About half were living in dwellings owned by their parents; the rest lived in rented or partly owned residences.

TABLE 1
Educational attainment

HIGHEST YEAR REACHED	MALE		FEMALE		TOTAL	
	<i>number</i>	<i>per cent</i>	<i>number</i>	<i>per cent</i>	<i>number</i>	<i>per cent</i>
HIGH SCHOOL:						
First Year ...	568	100.0	460	100.0	1028	100.0
Second Year .	512	90.1	422	91.7	934	90.9
Third Year ..	464	81.7	381	82.8	845	82.2
Fourth Year .	431	75.9	361	78.5	792	77.0
Graduated ...	430	75.7	361	78.5	791	76.9
COLLEGE:						
First Year ...	243 ^a	42.8	274 ^e	59.6	517	50.2
Second Year .	150 ^d	26.4	189 ^f	41.1	339	33.0
Third Year ..	48 ^c	8.4	41 ^g	8.9	89	8.7
Fourth Year .	6 ^b	1.1	19 ^h	4.1	25	2.4
Graduated ...	3	0.5	3	0.7	6	0.6

^a Sixteen are still studying.

^b Twenty-four are still studying.

^c Twenty-one are still studying.

^d Three are still studying.

^e Eleven are still studying.

^f Six are still studying.

^g Four are still studying.

^h Two are still studying.

TABLE 2
Occupational pursuits

OCCUPATIONAL GROUP	MALE		FEMALE		TOTAL	
	<i>number</i>	<i>per cent</i>	<i>number</i>	<i>per cent</i>	<i>number</i>	<i>per cent</i>
Teacher	30	5.9	146	35.3	176	19.1
Housekeeper	0	0.0	128	30.9	128	13.9
Businessman, merchant	70	13.7	29	7.0	99	10.8
Student	64	12.6	23	5.6	87	9.4
Soldier	61	12.0	0	0.0	61	6.7
Farmer	58	11.4	0	0.0	58	6.3
Laborer	42	8.2	0	0.0	42	4.6
Typist, steno- grapher	26	5.1	14	3.4	40	4.3
Clerk	26	5.1	6	1.5	32	3.5
Dressmaker	0	0.0	21	5.2	21	2.3
Salesman	8	1.6	8	1.9	16	1.7
Civilian guard (U. S. Army)	16	3.1	0	0.0	16	1.7
Driver	11	2.1	0	0.0	11	1.2
Checker (U. S. Army)	7	1.3	4	1.0	11	1.2
Mechanic	8	1.6	0	0.0	8	0.9
Nurse	0	0.0	8	1.9	8	0.9
Foreman	8	1.6	0	0.0	8	0.9
Attendant	2	0.4	5	1.2	7	0.8
Musician	7	1.3	0	0.0	7	0.8
Fisherman	6	1.2	0	0.0	6	0.7
Carpenter	5	1.0	0	0.0	5	0.6
Pharmacist, assist. pharma- cist	0	0.0	5	1.2	5	0.6
Beautician	0	0.0	5	1.2	5	0.6
Employee	5	1.0	0	0.0	5	0.6
Truck owner- operator	4	0.8	0	0.0	4	0.4
Tailor	4	0.8	0	0.0	4	0.4
Carromata driver	4	0.8	0	0.0	4	0.4
Butcher	3	0.6	1	0.2	4	0.4
Others (3 per- sons or less each)	34 ^a	6.8	45 ^b	2.5	79	4.5

^a Peddler, shoemaker, ticket seller, barber, electrician, baker, policeman, landlord, bookkeeper, telephone operator, assessor, messenger, cine operator, flying cadet, vehicle dispatcher, ice-cream maker, fireman, watch repairer, grapher, truck conductor, health officer, optician, umbrella maker.

^b Ticket seller, laundrywoman, record keeper, cashier, telephone operator, nun, pianist.

A STUDY OF THE INFLUENCE OF TWO CHICK RATIONS AND TWO METHODS OF BROODING ON THE RATE OF GROWTH AND MORTALITY OF CHICKS¹

LEOPOLDO S. CASTILLO

The two important factors considered in the raising of chickens are the quality of the ration given them and the method of brooding employed. For many years now the chick ration that has been giving highly satisfactory results in this college is one consisting of 55 per cent fine rice bran, 20 per cent ground yellow corn, 20 per cent shrimp meal, and 5 per cent copra meal, all parts by weight. It is not known, however, how this ration compares with an imported commercial chick ration now popularly used in the United States. As to the method of raising chickens, the one most commonly used by poultrymen in this country is that of confining the chickens in houses with either dirt or concrete floors provided with good litter, and giving them bare or grassy runs. The use of sun porches,² now very common in the United States, has never been tried here. With the aim of improving further the local satisfactory ration and method of brooding, the present study was conducted in the Department of Animal Husbandry from December 17, 1946, to July 31, 1947, to compare the influence of the chick rations and of the use of a sun porch on the rate of growth and mortality of chicks.

Review of literature

According to Asmundson and Lerner (1942), the average growth-rate for Single Comb White Leghorn pullets from two to eight weeks old was 136.5 per cent. At the age of twelve weeks, Single Comb White Leghorn pullets in ten-year hatches averaged 1.67 lbs. (0.76 kgm.) in weight but showed a gradual decrease in weight-gain after that age (Kempster, 1941). Jull (1943a) reported the average weight of White Leghorn males at the age of twelve weeks to be 2.28 lbs. (1.04 kgm.) and that of females, 1.78 lbs. (0.81 kgm.).

In the Philippines, on the other hand, Fronda and Yñiguez (1936) reported that Tamayo in 1934 observed that the average weight of twelve-week-old Single Comb White Leghorn chicks was only 470.7 grams. They further reported that at the age of four weeks, the chicks of this breed weighed 93.1 grams; at eight weeks,

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² By sun porch is meant the off-the-ground, roofless platform outside the house where the chicks have access to sunlight.

228.8 grams; and at twelve weeks, 468.8 grams; and that the mortality of the chicks studied up to their twelfth week of age was 55.10 ± 5.303 per cent.

Regarding confinement brooding, a comparison of the different methods was made by Hinds (1937) in which he used brooder houses with concrete floor and concrete porch, wire floor and wire porch, and concrete floor with outside run. His results indicated little difference in the rate of growth between the lots. In a comparative study of four methods of raising chicks made by Mehrhoff, Ward, and Moore (1943), they reported that twelve-week-old pullets raised in battery brooder, sun parlor, "clean land," and "used land" weighed 1.72 lbs. (0.78 kgm.), 1.72 lbs. (0.78 kgm.), 1.67 lbs. (0.76 kgm.), and 1.76 lbs. (0.80 kgm.), respectively. They further observed that to produce 1 lb. (0.45 kgm.) of gain the battery brooder required 5.03 lbs. (2.29 kgm.) of feed; sun parlor, 6.31 lbs. (2.41 kgm.); "clean land," 4.93 lbs. (2.24 kgm.); and "used land," 4.97 lbs. (2.26 kgm.).

EXPERIMENTS, RESULTS, AND DISCUSSION

In the present study, the comparison was made between the ground-run and the sun-porch methods with 400 four-day-old imported sexed Single Comb White Leghorn chicks as subjects of the experiment. These chicks were supposed to be 80 per cent pullets and 20 per cent cockerels. The chicks were wing-banded and randomized into four lots of 100 chicks each. On the fourth day of the experiment, however, an accident³ reduced the number, so that the chicks had to be reallocated, each of lots I, II, and III having 81 chicks and lot IV, 80 chicks. The rations given to the different lots and the methods of brooding these lots were as follows:

LOT	RATION	METHOD OF BROODING
I	College	Ground run
II	Imported	Ground run
III	College	Sun porch
IV	Imported	Sun porch

The sun porches were made of bamboo slats spaced about one and one-half centimeters apart. The chicks were provided with identical fireless brooders and concrete-floor scratching pens with rice hulls used as litter. The sun porches and ground runs had the same area.

During the day, the chicks were allowed the scratching pens and ground runs or sun porches, as the case may be. At dusk the chicks were confined in the fireless brooders for the night, and in the morning, they were let out into the scratching pens. When the chicks were about four weeks old, they were allowed to roost on low porches provided for them, instead of being placed in the fireless brooders. Every morning finely cut green grass was given the chicks and the rations were made available to them, *ad libitum*.

³ A cat entered one of the pens and killed 77 of the chicks.

During the first few days, the chicks were exposed to morning sunlight for gradually increasing lengths of time. On the third week, the feeds and water were also placed outside the house to encourage the chicks to go out. The hand-feeding of finely cracked yellow corn to all the lots was started in the fifth week. The corn was given twice daily, in the morning and in the afternoon, in the amount of about one-fourth of the ration. Ground shell in open bamboo troughs was placed on the ground runs and sun porches.

The weanlings in all the lots were culled at the end of the brooding period, when the cockerels were also separated. Culling was based on the following points: general appearance, vigor, size, and pigmentation. The selected pullets were left in their own lots up to the twentieth week, when they were transferred to the laying pens. The college rearing ration was given to all the pullets after they were weaned. The change of the ration in the case of those fed with the imported one was made gradually.

Records kept. Records were kept of the initial weights of the four-day-old chicks taken at the beginning of the experiment with an Ohaus balance with a capacity of 2000 grams and sensitive to 0.1 gram, of their biweekly weights until the twelfth week, of the amounts of feed consumed by the different lots up to the twelfth week, and of the mortality among the birds. Other observations were also recorded.

Rate of growth. Table 1 shows that in all the lots, the initial weights of the chicks were practically the same but were trebled at the end of the first four weeks. At weaning age, the average weights of the chicks were as follows: lot I, 652.6 ± 22.0 grams; lot II, 542.7 ± 29.0 grams; lot III, 600.6 ± 24.8 grams; and lot IV, 503.5 ± 19.8 grams. These mean weights are higher than those obtained by Tamayo (1934) and Fronda and Yñiguez (1936), but they are very much lower than those reported in the United States (Jull, 1943b; Kempster, 1941; and Mehrhoff *et al.*, 1943).

As influenced by the rations, the chicks in lots I and II, which had access to the ground runs, showed significant differences from the fourth to the twelfth week. At the end of the brooding period, the difference between lot I and lot II was 109.0 ± 36.4 grams in favor of the former. The chicks in lots III and IV, which had access to the sun porches instead of the ground runs, showed a significant difference at the end of the second week in favor of lot IV, which received the imported ration. At the end of the brooding period, however, the chicks in the lot (III) that received the College ration were significantly heavier than those which received the imported ration (lot IV). The difference was 97.1 ± 31.7 grams.

The effect of the method of brooding used may be seen by comparing in table 1, lot I (ground run) with lot III (sun porch), both of which received the College ration, and lot II (ground run) with lot IV (sun porch), both of which received the imported ration. In general, the difference between the two methods used was insignifi-

cant, although the chicks in the lots with the ground runs were slightly heavier than those with the sun porches. At the end of the second, sixth, and eighth weeks, the ground-run-reared chicks were significantly heavier than the sun-porch-reared in both lots that received the College ration. In the imported ration group, the chicks in the sun-porch lots were significantly heavier at the end of the fourth week than those in the ground-run lots. At the end of the eighth week, however, the comparison was reversed—that is, the latter were significantly heavier than the former. At the close of the brooding period, the weight difference between the two methods of brooding was insignificant.

On the assumption that to the heaviest average weight of weanlings may be assigned 100 per cent efficiency, the relative efficiencies of lots, I, II, III, and IV were computed to be 100.0, 81.1, 92.0, and 77.1 per cent, respectively.

The average rate of growth is expressed in terms of per cent (see table 2). The following formula (Asmundson and Lerner, 1942) was used in the computation:
$$R = \frac{W_2 - W_1}{\frac{1}{2}(W_2 + W_1)} \times 100;$$

where W_2 is the final weight in the period considered, and W_1 is the initial weight. As influenced by the rations given, from the fourth day to the twelfth week lot I had better growth rates than lot II, and lot III better than lot IV. With regard to the methods of brooding used, the chicks given the ground runs had better growth rates than those with access to sun porches.

This study shows that the trend was for the biweekly rates of growth to decrease as the chicks grew older, and that the growth rates of the chicks in all lots from the second to the eighth week were less than those reported by Asmundson and Lerner (1942). Furthermore, the rate of growth was not constant. The incidence of a disease that killed many of the chicks may account for the abrupt decrease in the rate of growth in all the lots at the end of the sixth week.

Mortality. The greatest mortality occurred during the fifth and sixth weeks (see table 3), when a disease suspected to be coccidiosis broke out in all the lots. Unmistakable symptoms of this disease were noted about the end of the fifth week. The presence of this disease provided an excellent opportunity to observe if the rations given to the chicks had any influence on the effect of the disease. After about a week, when it was observed that the lots fed with the imported ration would be decimated, all the lots were given the sulfa-guanidine treatment, which reduced the percentage of mortality in the following week.

At the end of the brooding period, the percentages of mortality were lot I, 30.7; lot II, 76.6; lot III, 35.8; and lot IV, 72.5. Subjected to the adjusted chi-square tests, the difference in the mortality as influenced by the rations studied was highly significant in favor of the College ration. On the other hand, the mortality that may be

attributed to the methods used in brooding was insignificant. Computed on the basis of 100 per cent efficiency for the lot with the least mortality, the relative efficiencies as influenced by the rations were 100, 40.1, 85.7, and 42.3 per cent for lots I, II, III, and IV, respectively.

Barger and Card (1943) cited the studies made by Becker (1937) on the effect of feeds upon coccidial infection. Becker claimed that the extreme severity manifested in certain outbreaks of coccidiosis was attributable not only to the microorganisms but also to certain materials incorporated in the ration to stimulate growth of the birds. He said that powdered skim milk and buttermilk in certain chick rations seemed to be the most flagrant offenders in this regard, with the presence of middlings as another possibility. Both wheat middlings and dried skim milk are important ingredients contained in the imported ration used.

Quality of weanlings produced. Table 4 shows the quality of the chicks at the end of the brooding period. The birds were classified into three grades—A, B, and C—according to their general appearance, vigor, size, and pigmentation. The results of this classification showed that the College ration produced not only more but also better quality weanlings than the imported ration. All the birds that were classified under class C were culled and those under A and B were retained. As may be seen in table 4, in lot I, 46 weanlings were retained and 10 were culled, while in lot II, 12 were retained and 7 culled. From lot III, 45 were selected and 7 culled and from lot IV, 17 were retained and 5 culled. The number of pullets left after culling were as follows: 31, or 38.3 per cent of all selected pullets at weaning in lot I; 7, or 8.6 per cent, in lot II; 28, or 34.6 per cent, in lot III; and 15, or 18.5 per cent, in lot IV. The relative efficiencies of the lots as influenced by the rations were 100, 22.6, 90.3, and 48.4 per cent for lots I to IV in the order named. The computation was made on the assumption that the lot with the highest percentage of selected pullets was 100 per cent efficient.

Amount of feed required to produce a unit of gain. It was observed that the lots fed with the College ration consumed more feed than those fed with the imported ration (lots I and III compared with lots II and IV in table 5). The chicks on the ground runs (lots I and II combined) consumed more than those on the sun porches (lots III and IV). Computed on the basis of 100 chicks, the consumption of lot I was 305.9 kilograms; lot II, 273.1 kilograms; lot III, 288.8 kilograms; and lot IV, 257.6 kilograms. Lot I required 503.9 kilograms of feed to produce 100 kilograms of gain; lot III, 520.4 kilograms; lot II, 548.4 kilograms; and lot IV, 562.4 kilograms. These results corroborated the finding of Mehrhoff *et al.* (1943) that the sun parlor required more feed to produce a unit of gain. If the lot which required the least feed to produce 100 kilograms of gain is considered the most efficient, the relative efficiencies in per cent would be as follows: 100.0, 91.9, 96.8 and 89.6 for lots I, II, III, and IV, respectively.

Sexual maturity of pullets. By comparing lot I with lot II in table 6, it may be seen that the pullets which were fed the College chick ration laid their first eggs significantly earlier than those fed with the imported chick ration. The pullets in the former lot laid their first eggs when they were 163.1 ± 3.5 days while those of the latter lot laid when they were 177.2 ± 5.5 days old, with a significant difference of 14.1 ± 6.5 days. In the sun porches, however, the pullets in lots III and IV laid at about the same age, that is, the pullets of the former lot laid when 165.4 ± 3.5 days old while those of the latter laid when 166.1 ± 2.3 days old.

As may be expected, the pullets in lots I and III were significantly heavier when they laid their first eggs than those in lots II and IV, but the weights of the first eggs in all the lots were about the same. At the end of the thirty-second week, all the pullets in lots I, II, and IV were sexually mature. In lot III, however, two pullets had not laid any egg in the trapnest by the thirty-second week.

Other observations. During the first few weeks of the experiment, the chicks fed with the imported ration had loose bowels. They had dirty feathers around the vent and in the abdominal region. On the other hand, the chicks fed with the College chick ration were relatively cleaner and more active.

The grass growing on the ground run used by the chicks fed with the imported ration did not show any sign of depletion even during the first three weeks when the mortality of the lot was comparatively low. On the other hand, the lot fed with the College ration showed signs of depletion beginning with the third week. This run was laid bare by the chicks on the sixth week of the experiment. The tendency of the chicks in the former lot to forage less may be ascribed to the presence of a large amount of alfalfa-leaf meal in the imported ration.

Pigmentation was also used in judging the weanlings. The birds were grouped into three grades—those with yellow shanks, those with medium yellow, and those with no visible pigment on ocular inspection. Of the birds that received the College ration, 40.9 per cent had yellow shanks, 31.5 per cent had medium yellow, and 6.7 per cent had no pigment at all. On the other hand, of those fed with the imported ration, only 1.3 per cent had yellow shanks, 19.5 per cent had medium yellow, and 6.7 per cent had no pigment at all. These differences in pigmentation of the weanlings may have been due to the kind of ration given to the birds. The intensity of the yellow pigment in naturally pigmented birds like the Leghorns is considered a good indication of the vigor of the birds, according to Rice, Hall, and Marble (1930). That the College-ration-fed chicks had yellow shanks is another proof that they were more vigorous than those that received the imported ration.

SUMMARY

1. The College chick ration fed to S. C. White Leghorns was superior to the imported ration on the basis of the following:

a. In the ground-run lots, the chicks fed with the College ration weighed 652.6 ± 22.0 grams, while those fed with the imported ration weighed 542.7 ± 29.0 grams, with a significant difference of 109.9 ± 36.4 grams in favor of the former. In the sun-porch lots, the chicks fed with the former ration weighed 600.6 ± 24.8 grams as against the weight of 503.5 ± 19.8 grams of the chicks fed with the latter ration. There was a significant difference of 97.1 ± 31.7 grams.

b. At the end of the brooding period, the percentages of mortality in the ground runs were 30.7 for lot I (College chick ration) and 76.6 for lot II (imported chick ration); in the sun porches, 35.8 for lot III (College chick ration) and 72.5 for lot IV (imported chick ration). These results gave highly significant lower mortality for the College chick ration.

c. In the ground-run and sun-porch lots it took 503.9 and 520.4 kilograms of feed, respectively, for the chicks fed with the former ration to produce 100 kilograms of gain each, while those fed with the latter ration each required 548.4 and 562.4 kilograms of feed, respectively.

d. In both methods of brooding, 72.9 per cent of all the selected pullets at weaning were fed with the former ration, while those fed with latter ration gave only 27.1 per cent.

2. The results of the study showed that there was apparently no advantage derived from the use of sun porches over that of the ground runs, for:

a. At the end of the brooding period, the weight difference between the two methods was insignificant.

b. Both the ground-run and sun-porch methods each totaled 87 dead chicks at the end of the brooding period.

c. The sun-porch chicks fed with the College chick ration required 16.5 kilograms more of feed than the ground-run chicks fed with the same ration to produce 100 kilograms of gain, while the sun-porch chicks fed with the imported ration required 12.0 kilograms of feed more than the ground-run chicks to produce 100 kilograms of gain.

LITERATURE CITED

- ASMUNDSON, V. S., AND I. MICHAEL LERNER. 1942. Breeding chickens for meat production. California Agric. Exper. Sta. Bull. 675: 1-45.
- BARGER, EDGAR HUGH, AND LESLIE ELLSWORTH CARD. 1943. Diseases and parasites of poultry. 399 p., 83 fig. Philadelphia: Lea and Febiger.
- BECKER, E. R. 1937. Dietary control in experimental coccidiosis. Science 86: 403-404. Cited by Barger, Edgar Hugh, and Leslie Ellsworth Card. 1943. *ibid.*
- BRIGGS, GEORGE, M., AND MORLEY A. JULL. 1946. Feeds and feeding practices for chickens. Maryland Agric. Ext. Service Bull. 109: 1-27.
- FRONDA, F. M., AND BONIFACIO T. YÑIGUEZ, 1936. A comparative study of the chicks of five different breeds of poultry. Philippine Agriculturist 25: 105-119.

- HINDS, H. B. 1937. Confinement rearing. Part II. Arizona Agric. Exper. Sta. Bull. 159: 177-182.
- JULL, MORLEY, A. 1943a. Rearing chickens for meat and egg production. Maryland Agric. Ext. Service Bull. 100: 1-53.
- JULL, MORLEY, A. 1943b. Successful poultry management. xi + 467 p., 187 fig. New York: McGraw-Hill Book Company, Inc.
- KEMPSTER, H. L. 1941. The normal growth of chickens. Missouri Agric. Exper. Sta. Bull. 423: 1-20.
- MEHRHOFF, N. R., W. F. WARD, AND O. K. MOORE. 1943. Effect of method of rearing S. C. White Leghorn chicks upon rate of growth, feed efficiency, and mortality. Florida Agric. Exper. Sta. Bull. 394: 1-12.
- RICE, JAMES E., GOLDAN O. HALL, AND DEAN R. MARBLE. 1930. Judging poultry for production. xii + 425 p., 205 fig. New York: John Wiley and Sons, Inc.

TABLE 1

Biweekly weights of S. C. White Leghorn chicks as influenced by the rations fed and by the methods of brooding

AGE	GROUND				SUN PORCH			
	LOT I		LOT II		LOT III		LOT IV	
	No.	Weight	No.	Weight	No.	Weight	No.	Weight
		grams		grams		grams		grams
4 days	81	45.6 ± 0.5	81	45.1 ± 0.6	81	46.1 ± 0.6	80	45.5 ± 0.4
2 weeks	80	82.9 ± 1.4	76	82.0 ± 1.6	81	75.3 ± 1.4	76	81.3 ± 1.1
4 "	77	143.1 ± 2.9	71	133.0 ± 2.2	73	139.0 ± 3.5	73	142.1 ± 2.4
6 "	71	221.4 ± 7.0	29	180.7 ± 7.9	64	188.8 ± 6.3	35	194.9 ± 4.7
8 "	61	323.0 ± 3.6	19	296.9 ± 5.0	55	280.5 ± 11.0	25	271.4 ± 9.5
10 "	57	491.8 ± 18.0	19	421.7 ± 26.1	52	445.3 ± 19.8	23	402.5 ± 16.5
12 "	56	552.6 ± 22.0	19	542.7 ± 29.0	52	600.6 ± 24.8	22	503.5 ± 19.8
Relative efficiency ^a , per cent		100.0		81.1		92.0		77.0

^a Considering the lot that had the heaviest weanlings as 100 per cent efficient.

TABLE 2

Average growth rates of S. C. White Leghorn chicks as influenced by the rations fed and by the methods of brooding

AGE IN WEEKS	GROUND RUN		SUN PORCH	
	LOT I	LOT II	LOT III	LOT IV
	<i>per cent</i>	<i>per cent</i>	<i>per cent</i>	<i>per cent</i>
2	59.9	58.1	48.1	56.5
4	53.3	47.4	59.5	54.4
6	43.0	30.4	30.4	31.3
8	37.3	47.7	39.1	32.8
10	41.4	34.7	45.4	38.9
12	28.1	25.1	29.7	22.3
4th day to 12th week	173.9	169.3	171.5	166.9

TABLE 3

Biweekly mortality of S. C. White Leghorn chicks as influenced by the rations fed and by the methods of brooding

AGE IN WEEKS	GROUND RUN				SUN PORCH			
	LOT I		LOT II		LOT III		LOT IV	
	No.	Per cent	No.	Per cent	No.	Per cent	No.	Per cent
2	1	1.2	5	6.2	0	0.0	4	5.0
4	3	3.7	5	6.2	8	9.9	3	3.7
6	6	7.4	42	51.9	9	11.1	38	47.5
8	10	12.3	10	12.3	9	11.1	10	12.5
10	4	4.9	0	0.0	3	3.7	2	2.5
12	1	1.2	0	0.0	0	0.0	1	1.3
Total	25	30.7	62	76.6	29	35.8	58	72.5
Relative efficiency, ^a per cent	100.0		40.1		85.7		42.3	

^a Considering the lot with the least mortality as 100 per cent efficient.

TABLE 4
Quality of S. C. White Leghorn weanlings produced

LOT	SEX	GRADES			RELATIVE EFFICIENCY ^a
		A	B	C	
I	Male	11	4	6	<i>per cent</i> 100.0
	Female	24	7	4	
II	Male	5	0	0	22.6
	Female	5	2	7	
III	Male	7	10	0	90.3
	Female	20	8	7	
IV	Male	0	2	0	48.4
	Female	8	7	5	

^a Considering the lot that gave the biggest number of selected pullets as 100 per cent efficient.

TABLE 5

Kilograms of feed required to produce 100 kilograms of gain

ITEM	GROUND		SUN PORCH	
	LOT I	LOT II	LOT III	LOT IV
Average weight of 100 4-day-old chicks, kgm.	4.6	4.5	4.6	4.5
Average weight of 100 12-week-old chicks, kgm.	65.3	54.3	60.1	50.3
Average gain in weight, kgm.	60.7	49.8	55.5	45.8
Total feed consumed in twelve weeks, kgm. ..	305.9	273.1	288.8	257.6
Kilogram feed required for 100-kgm. gain ...	503.9	548.4	520.4	562.4
Relative efficiency, ^a per cent	100.0	91.9	96.8	89.6

^a Considering the lot that required the least amount of feed to produce a unit of gain 100 per cent efficient.

TABLE 6

Sexual maturity of pullets raised to the age of 32 weeks

ITEM	LOT			
	LOT I	LOT II	LOT III	LOT IV
Number of pullets	28	7	27	14
Minimum age when first egg was laid, days . . .	137.0	158.0	130.0	151.0
Mean age of pullets on laying first eggs, days.	163.1 $\pm$ 3.5	177.2 $\pm$ 5.5	165.4 $\pm$ 3.5	166.1 $\pm$ 2.3
Mean weight of pullets on laying first eggs, grams	1363.8 $\pm$ 22.3	1262.2 $\pm$ 32.8	1875 $\pm$ 32.8	1223.3 $\pm$ 24.3
Mean weight of first eggs, grams	35.0 $\pm$ 1.7	34.3 $\pm$ 0.3	34.6 $\pm$ 0.4	34.3 $\pm$ 0.8
Percentage of pullets that had laid at the age of 32 weeks	100.0	100.0	92.6	100.0

PHOTOCHLORINATION OF A HOMOLOGOUS SERIES OF FATTY ACIDS FROM COCONUT OIL¹

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Of the Department of Agricultural Chemistry

WITH ONE TEXT FIGURE

Banzon (1948a) and Banzon and Maramba (1948b) recently described the chlorination of coconut oil and other vegetable oils with the aid of direct sunlight; the resulting product was a resinous solid or semi-solid of high chlorine content. Since 94 to 96 per cent of vegetable oils are fatty acid, the chlorination of a homologous series of fatty acids may throw some light on the mechanism of the reaction of vegetable oils with chlorine. Coconut oil contains a homologous series of fatty acids of even-numbered carbon atoms and may therefore be conveniently used as a source of the desired fatty acids. According to Birosel, Millar, Nessia, and Tagorda (1939) the fatty acid content of coconut oil is distributed as follows:

Caproic .. 0.38 per cent	Lauric.. 55.06 per cent	Stearic .. 0.00 per cent
Caprylic.. 6.54 " "	Myristic.. 16.89 " "	Linoleic.. 0.81 " "
Capric ... 8.95 " "	Palmitic.. 7.36 " "	Oleic ... 4.01 " "

The present investigation was limited to the study of the behavior of the individual fatty acids towards the chlorination reaction, the measurements of the amounts of chlorine involved in the reaction, and the determination of some physical properties of the chloro-compounds formed. The experiments were carried out in the Department of Agricultural Chemistry of the College of Agriculture from April to September, 1947.

Isolation of individual fatty acids from coconut oil. Two-hundred-gram portions of coconut oil were saponified with 15 per cent sodium hydroxide solution. The amount of NaOH used was slightly in excess of the theoretical quantity required based on the saponification number. The oil-lye mixture was warmed, thoroughly stirred, and set aside overnight. The resulting soap was dissolved in hot water. A clear transparent solution indicated complete saponification. The solution was poured into warm 15 per cent sulfuric acid and carefully stirred until the oily layer of fatty acids was formed. The mixture of fatty acids was washed three times with warm water and dried with anhydrous sodium sulfate.

¹ Experiment Station Contribution No. 1503. Presented by the senior author as thesis for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture, October, 1947. Prepared in the Department of Agricultural Chemistry under the direction of the junior author.

Fractionation of the mixture into individual fatty acids was performed in a simple still patterned after the apparatus described by Hilditch (1944). The still shown in figure 1, (upper figure)

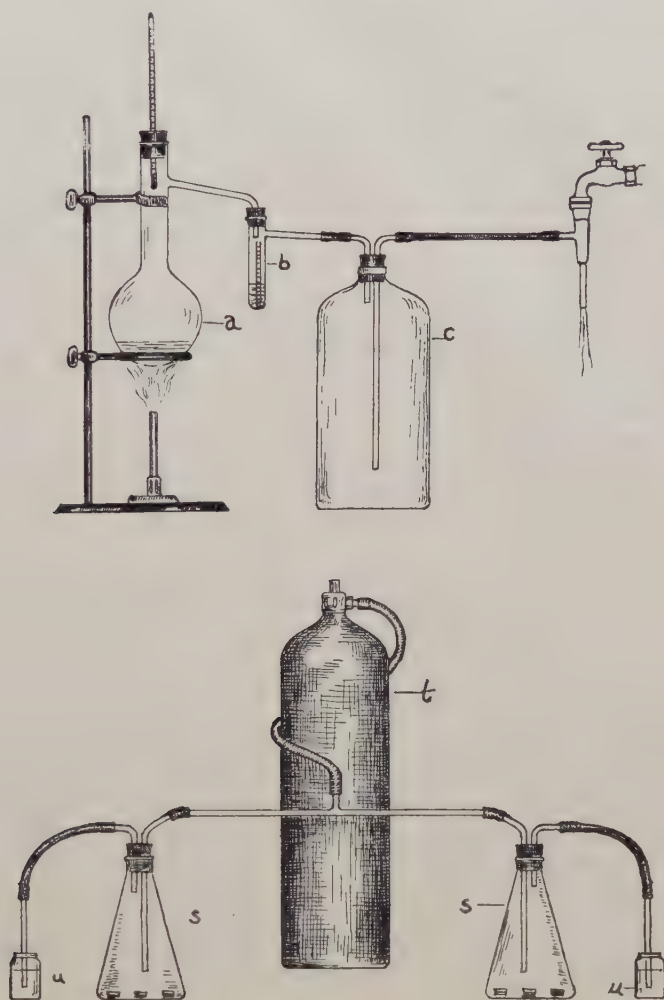


Fig. 1 — Upper figure. Distillation assembly for fatty acids showing distilling flask *a*, receiver *b*, and pressure stabilizer *c*. Lower figure. Chlorination assembly showing sample container *r*, reaction flask *s*, chlorine tank *t*, and sodium carbonate solution *u*.

could handle 200 grams of material. An initial distillation was carried out to obtain a rough separation. The fractions were repeatedly distilled until the apparent purity as determined by titra-

tion was at least 95 per cent. The molecular weights of the isolated fatty acids were computed from their neutralization values (table 1).

Considerable difficulty was encountered in isolating oleic and linoleic acids from coconut oil by the apparatus on hand. Oleic acid for this study was obtained by purifying commercial oleic acid through repeated crystallization at 10° C.; the impurities, largely stearic acid and palmitic acid, were frozen and removed, leaving in liquid form oleic of greater purity. A mixture of linoleic and linolenic acids prepared from the fatty acids of linseed oil through repeated freezing at 0° C. was employed in this investigation. The fraction which remained in the liquid form was considered relatively pure linoleic-linolenic acid, inasmuch as 84 per cent of linseed-oil fatty acids consist of these two acids. The isolation of stearic acid from coconut oil was not attempted, although several workers were cited by Bailey (1945) as finding this acid in coconut oil. Stearic acid was isolated from the fatty acids of beef tallow by pressing out the liquid constituents (oleic acid) and repeatedly crystallizing the stearic acid from warm alcohol.

The neutralization value and melting point of the isolated fatty acids were determined according to the methods described by Jamieson (1932). The data presented in this paper are based on three separate batches of fatty acids purified according to the methods described.

The chlorination of the fatty acids. Samples of the fatty acids were weighed in thin glass vials 15 mm. high and 18 mm. in diameter. The weights of the fatty acids used in the experiments varied from 0.4700 to 0.7100 gram. The vials containing the weighed samples were carefully lowered into the bottom of a one-liter Erlenmeyer flask. The flask was fitted with a rubber stopper with two glass tubes; one extended to 30 mm. of the bottom of the flask for chlorine inlet and the other, for outlet of any gaseous products of the reaction. The gaseous products passing through the outlet tube were absorbed in an aqueous solution of sodium carbonate. The fatty acid samples in the flask were exposed to the bright noonday sun while chlorine was introduced slowly. The apparatus assembly is shown in figure 1, lower figure. The increase in weight of the samples was determined hourly by weighing them in an analytical balance.

RESULTS AND DISCUSSION

Behavior of the fatty acids towards chlorination in sunlight. All the fatty acids studied reacted readily with the gaseous chlorine in sunlight. The reaction was manifested by the appearance of numerous tiny bubbles on the surface of the fatty acids, by the increase in viscosity, and by the evolution of large quantities of hydrogen chloride gas. These results are similar to those obtained by Banzon (1948a) and Banzon and Maramba (1948b) in the

chlorination of some vegetable oils. In the case of the linoleic-linolenic acid, there was a marked change in color; the light yellowish brown of the original acid became almost black in one hour of chlorination. The oleic acid samples also changed color from light yellow to dark brown. The fatty acids of the saturated series from C_8 to C_{18} did not change in color and remained colorless and transparent. All the fatty acids studied also progressively increased in weight in the hourly weighings. The linoleic-linolenic acid attained a constant weight after the fourth weighing (four hours of chlorination). The saturated fatty acids and the oleic acid increased in weight up to the sixth hour (table 2). When the chlorinated fatty acids were allowed to cool to room temperature, a smooth shiny crust was formed on the surface of the chlorinated linoleic-linolenic acid and the chlorinated oleic acid.

Rate of reaction with chlorine. The hourly weighings showed that the fatty acids increased progressively in weight as chlorination proceeded. As shown in table 2, the greatest increase in weight was obtained in the first hour of chlorination. The saturated acids increased in weight faster than the oleic acid samples. The linoleic-linolenic acid reacted the fastest; it reached equilibrium in four hours and showed appreciable increase in weight after the fourth hour. The other fatty acids increased in weight up to the sixth hour. At the sixth hour, the shorter the carbon chain of the fatty acid, the greater the observed increase in weight (table 2). This observation seems to indicate that among the homologous saturated fatty acids the reaction with chlorine in sunlight tends to slow down as the length of the carbon chain is decreased.

Calculations from the increase in weight

From the increase in weight certain calculations are possible which may throw some light on the mechanism of the chlorination reaction. Also, the probable compounds formed may be deduced.

The weight of combined chlorine, in the case of the saturated fatty acids, may be computed from the measured increase in weight by means of the following equation proposed in an earlier paper (Banzon, 1948a):

$$x = 1.03 \Delta w$$

where X is the computed weight of combined chlorine, and Δw , the measured increase in weight. In the case of unsaturated acids, the increase in weight of the acid will be due to the weight of chlorine reacting by addition to the double bonds and the weight of chlorine reacting by replacement of hydrogen minus the weight of the hydrogen replaced. Since the reaction of an unsaturated compound with a halogen is supposed to take place first by addition and then after all unsaturation has been satisfied by replacement, information regarding the amounts of chlorine that combined by

addition and by replacement is of value. An equation to determine the weight of chlorine reacting by replacement may be derived as follows:

Let x be the weight of chlorine reacting by replacement per gram of fatty acid

y , the weight of hydrogen displaced

Δw , the total measured increase in weight

a , the number of double bonds in the fatty acid

b , the molecular weight of the fatty acid

Then $2a$ is the number of chlorine atoms reacting by addition to the double bond per mole

$2a \times 35.46$ is the weight of chlorine reacting by addition per mole

Then $\frac{2a \times 35.46}{b}$

is the weight of chlorine reacting by addition per gram of the acid.

$$\text{Therefore, } \Delta w = x - y + \frac{(2a \times 35.46)}{b}$$

$$\text{and since } y = \frac{x}{35.46} \text{ and substituting this in the above equation,}$$

$$\Delta w = 0.971 x + 71 \frac{a}{b}$$

where Δw is the observed increase in weight; $71 \frac{a}{b}$ is the weight of Cl combined by addition.

$$\text{Solving for } x \text{ in the preceding equation, } x = 1.03 \Delta w - 73 \frac{a}{b} .$$

$$\text{The total combined Cl is } x + 71 \frac{a}{b} .$$

Thus for oleic acid, where $a = 1$, $b = 284$, and $\Delta w = 0.678$, the weight of Cl combined by replacement is 0.443 and that combined by addition to the double bond is 0.250; the total combined chlorine is therefore 0.690.

The weights of combined chlorine computed according to these equations are given in table 3, column 2. Calculated for each mole of fatty acid, the corresponding values are given in column 3 of table 2. It may be seen from these figures that the weight of combined chlorine when computed for a gram of acid tends to increase as the length of the carbon chain of the fatty acid decreases; calculated for each mole, the trend is reversed. The unsaturated acids show less combined chlorine than the saturated acids. Column 4 of table 3 gives the percentage of chlorine in the final chlorinated product. These figures were obtained by dividing the figures in column 2 by the figures in column 1 increased by one gram. It is shown that the calculated percentage of chlorine in the final product is close to 50 and that the shorter the carbon chain of the fatty acid, the greater the chlorine content of the product. The unsaturated acids again gave products which contained less chlorine than those derived from the saturated acids.

Column 5 of table 3 shows the computed number of combined chlorine atoms for each mole of fatty acid. These figures are obtained by dividing the values in column 3 by the atomic weight of chlorine.² Among the saturated fatty acids the calculated number of combined chlorine atoms attained a maximum of about seven. Assuming that the chlorination reaction consisted only of the replacement of hydrogen atoms of the fatty acid chain by chlorine atoms, the probable compounds formed in the case of lauric acid are heptachloro and hexachlorolauric acids.

The calculated number of chlorine atoms to a mole of fatty acid tended to increase from the C_8 acid to the C_{14} acid; it remained practically constant from the C_{14} to the C_{18} acid. It is probable that the high viscosity obtained during chlorination had an influence on the limit of chlorination because high viscosity impedes the thorough mixing of the reactants. There is an indication, however, that factors other than viscosity influenced the reaction. The chlorinated C_8 acid, for example, was the least viscous among the saturated acids, but it contained the least number of chlorine atoms to a mole. The phenomenon of steric hindrance may be invoked here to explain the situation at least in part. Among the saturated acids it is probable that at the start all hydrogen atoms are equally replaceable, and therefore the entering chlorine atom can displace any of the hydrogen atoms, the position in the molecule being governed by chance. The succeeding chlorine atom replaces another hydrogen atom at random but will evade proximity to the first chlorine atom. Nearness to each other may cause distortion in the molecule because chlorine atom is so much larger than the hydrogen atom that overcrowding results. In effect, this is steric hindrance. As more and more chlorine atoms enter the fatty acid molecule, steric hindrance may effectively prevent further entry of chlorine, although there are still many hydrogen atoms replaceable. Thus, the C_8 acid with 15 theoretically replaceable H (table 3, column 6) can take in 4 to 5 Cl atoms (4.7 atoms), while the C_{10} acid with 19 replaceable H atoms can combine with 5 to 6 Cl atoms. With acids of longer chains of carbon like the C_{14} , C_{16} , and C_{18} , other factors like viscosity probably predominate. The percentage replacement of H atoms by Cl atoms was computed and is shown in table 3, column 7. Among the saturated fatty acids from C_8 , to C_{18} , the percentage replacement decreased as the length of the carbon chain of the fatty acid increased. Lauric acid appeared to have a percentage replacement of 28.8 per cent. We have pointed out in an earlier paper that a complete system of double bonds will be ex-

² Calculation of the number of Cl atoms, n , may be made directly from the increase in weight per mole Δw as follows: for replacement reaction, $\Delta w = 35.46 n - 1.008n$ per mole, or $n = \frac{\Delta w}{34.5}$; for replacement reactions

and addition to double bonds, $\Delta w = 71a + 35.46n - 1.008n$, or $n = \frac{\Delta w - 71a}{34.5}$
where a = no. of double bonds.

The unsaturated fatty acids darkened upon chlorination. The chlorinated oleic acid was dark brown while the chlorinated linoleic-linolenic acid was black. The saturated fatty acids, which were colorless and transparent and had remained in this condition during chlorination, changed to opaque white on standing.

SUMMARY

1. The fatty acids from coconut oil were isolated and purified. The chlorination of homologous saturated fatty acids from C_8 to C_{18} was performed in direct sunlight. Oleic and linoleic-linolenic acids were also prepared and chlorinated. In chlorination, the shorter the carbon chain of the fatty acid, the greater the percentage increase in weight and the percentage replacement of hydrogen atoms in the fatty acid.

2. Calculations based on the increase in weight indicated that a maximum of 6 to 7 chlorine atoms had been introduced into the fatty acid molecule; hexa- and heptachloroacids were presumably the compounds formed. It appeared that the maximum number of Cl atoms emplaced in the molecule was independent of the length of the carbon chain.

3. The unsaturated fatty acids studied (oleic and the linoleic-linolenic mixture) were found to react with less chlorine than the saturated acids. There was evidence that the chlorine taken in by the linoleic-linolenic acid was just about the quantity necessary to satisfy the two double bonds in linoleic acid and that no replacement reaction took place.

4. The rate of reaction of oleic acid with chlorine was slower than that of the saturated acids; the rate for linoleic-linolenic was greater.

5. The phenomenon of steric hindrance is tentatively proposed as an explanation for the apparent slow reaction of the oleic acid, the inability of linoleic-linolenic acid to combine with more chlorine, and the combination with the saturated fatty acids of a limited number of Cl atoms. High viscosity of the chlorinated reaction products probably plays a part also in limiting the amount of combined chlorine.

LITERATURE CITED

- BAILEY, A. E. 1945. Industrial oil and fat products. x + 735 p. New York: Interscience Publishers, Inc.
- BANZON, JULIAN. 1948a. A photochemical reaction of some vegetable oils with chlorine gas. *Philippine Agriculturist* 31: 279-288. *Fig 1*.
- BANZON, JULIAN AND FELIX K. MARAMBA, JR. 1948b. Studies on a photochemical reaction of coconut oil with chlorine gas. *Philippine Agriculturist* 31: 289-297.
- BIROSEL, D. M., F. MILLAR, E. NESSIA, AND F. TAGORDA. 1939. Composition of coconut oil. *University of the Philippines Nat. Appl. Sci. Bull.* 7: 39.
- HILDITCH, T. P. 1944. The chemical constitution of fats. xi + 437 p. New York: John Wiley and Sons, Inc.
- JAMIESON, G. S. 1932. Vegetable fats and oils. 444 p. New York: The Chemical Catalog Co.

TABLE 1
Properties of the fatty acids used in this study

FATTY ACID	EXPERIMENTAL VALUES			VALUES ACCORDING TO JAMESON			CALC. APPARENT PURITY
	Melting point	Neutral- ization value	Molecular weight	Melting point	Neutral- ization value	Molecular weight	
	°C			°C			<i>per cent</i>
Caprylic, C ₈	18.°0	377.6	148.3	16.5	389.6	144.1	96
Capric, C ₁₀	27.8	323.9	172.9	31.3	326.2	172.1	99
Lauric C ₁₂	41.1	270.9	206.7	43.6	280.5	200.2	96
Myristic, C ₁₄	52.6	248.8	225.1	54.0	246.1	228.2	98
Palmitic, C ₁₆	58.5	216.7	258.2	62.6	219.1	256.3	98
Stearic, C ₁₈	65.8	206.3	272.0	69.3	197.5	284.3	95
Oleic	14.8	197.1	284.0	16.0	198.9	282.4	99
Linoleic — linolenic	—	201.8	(278.5)	—	—	—	—

TABLE 2

Average hourly increase in weight per gram of fatty acid upon chlorination in sunlight

FATTY ACID	FIRST HOUR	SECOND HOUR	THIRD HOUR	FOURTH HOUR	FIFTH HOUR	SIXTH HOUR
	<i>gram</i>	<i>gram</i>	<i>gram</i>	<i>gram</i>	<i>gram</i>	<i>gram</i>
Caprylic, C ₈	0.4696	0.2976	0.0961	0.0527	0.0386	0.0963
Capric, C ₁₀	0.5146	0.2841	0.0955	0.1006	0.0486	0.0587
Lauric, C ₁₂	0.5454	0.3878	0.0815	0.1185	0.0211	0.0484
Myristic, C ₁₄	0.5943	0.2519	0.0741	0.0927	0.0138	0.0238
Palmitic, C ₁₆	0.5533	0.1444	0.0530	0.1225	0.0029	0.0127
Stearic, C ₁₈	0.6936	0.0608	0.0561	0.0401	0.0060	0.0030
Oleic	0.3699	0.1136	0.0510	0.0888	0.0142	0.0341
Linoleic- linolenic	0.5111	0.0463	0.0103	0.0019	0.0	—

TABLE 3

Results of calculations based on the increase in weight upon chlorination; weight of combined chlorine for each gram and for each mole of a fatty acid, percentage of chlorine in the chloro-compound, number of chlorine atoms combined with each mole, and percentage of hydrogen in fatty acid replaced by chlorine.

FATTY ACID	INCR. IN WEIGHT PER GRAM	WEIGHT OF COMBINED CHLORINE PER GRAM	WEIGHT OF COMBINED CHLORINE PER MOLE	CHLORINE IN CHLORO- COMPOUND	CALC. NUMBER OF CL ATOMS PER MOLE	HYDROGEN ATOMS PER MOLE FATTY ACID	CALC. HYDROGEN REPLACED
	<i>grams</i>	<i>grams</i>	<i>grams</i>	<i>per cent</i>			<i>per cent</i>
Caprylic, C ₈	1.096	1.129	167.3	53.8	4.7	15	31.5
Capric, C ₁₀	1.126	1.159	200.2	54.5	5.6	19	29.5
Lauric, C ₁₂	1.103	1.136	234.8	54.0	6.6	23	28.8
Myristic, C ₁₄	1.049	1.081	243.2	52.7	6.8	27	25.2
Palmitic, C ₁₆	0.875	0.901	232.6	48.1	6.6	31	21.3
Stearic, C ₁₈	0.865	0.891	242.3	47.7	6.8	35	19.4
Oleic	0.678	(0.690)	195.3	41.0	(5.5)	33	(10.6)
Linoleic- linolenic	0.585	(0.585)		36.9	(4.6)	—	0

TABLE 4

Physical properties of the chlorinated fatty acids

FATTY ACID	SPECIFIC GRAVITY	REFRACTIVE INDEX	RELATIVE VISCOSITY	COLOR
	<i>30/30°C.</i>	<i>30°C.</i>	<i>seconds</i>	
Caprylic, C ₈	1.395	1.517	6	white, opaque
Capric, C ₁₀	1.493	1.519	9	" "
Lauric, C ₁₂	1.426	1.521	12	" "
Myristic, C ₁₄	1.454	1.520	14	" "
Palmitic, C ₁₆	1.407	1.515	16	" "
Stearic, C ₁₈	1.372	1.516	17	" "
Oleic	1.404	1.516	39	dark brown
Linoleic- linolenic	1.398	1.512	53	almost black

VARIABILITY IN PLANT AND GRAIN CHARACTERS OF FORTUNA RICE AS INFLUENCED BY METHODS OF CULTURE¹

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WITH ONE TEXT FIGURE

The Fortuna rice is one of the promising introductions in the College of Agriculture. It is a recognized commercial variety in the United States, and was originally developed by the rice breeders of the United States Department of Agriculture. Previous culture tests with Fortuna rice made by the senior author in 1942-1944 and 1945-1946 have shown that it is apparently a variety which has a wide range of adaptation, doing fairly well under either upland or lowland conditions.

In a letter to the senior author dated March 12, 1946, Jenkin W. Jones, Principal Agronomist in charge of Rice Investigations, United States Department of Agriculture, stated that Fortuna has been grown quite extensively in Central and South America under non-irrigated conditions.

To determine the adaptability of Fortuna rice to both the irrigated and the non-irrigated systems of rice culture in the Philippines, and to study the variability in plant and grain characters as influenced by methods of culture, an experiment was conducted from December, 1946, to January, 1948, in the experimental plots and laboratory of the Department of Agricultural Botany, College of Agriculture, Los Baños, Laguna.

EXPERIMENTS, RESULTS, AND DISCUSSION

The seeds of the Fortuna variety used in this study were received from Jenkin W. Jones through J. Mitchell Jenkins, Rice Experiment Station, Crowley, Louisiana in the early part of 1946. According to Jones,^{2,3} Fortuna is a pure line selection made in 1911 by Charles E. Chambliss and J. Mitchell Jenkins in the Rice Experiment Station at Crowley from the Pa Chaim variety which was introduced by the United States Department of Agriculture from Taiwan (Formosa) in 1905. It was released for commercial growing by the Department in co-operation with the Louisiana Agricultural Experiment Station in 1918. The seeds used in this work were from the first generation harvest under College conditions.

¹ Experiment Station Contribution No. 1504. Based on a thesis presented by the junior author for graduation with the degree of Bachelor of Science in Agriculture.

² JONES, J. W. 1936. Improvement in rice. U.S. Department of Agriculture Year-book 1936: 415-454.

³ JONES, J. W. 1941. Rice varieties and their comparative yields in the United States. U.S. Dept. Agric. Cir. 612: 1-34.

Preparation of the land and pots. A plot measuring approximately 200 square meters was plowed and harrowed three times.

On June 27, 1947, furrows 30 centimeters apart, were made with a wooden spike-toothed harrow.

Ten pots made from 50 empty gallon oil drums, cut to one-half their original size, with drainage holes were used. The pots were filled with soil to about 10 centimeters from the rim and were placed in a row on an elevated portion of the field to facilitate drainage.

Preparation of the seedbed. The seedbed was prepared by the ordinary wet-bed method. Tap water was turned in, and after 15 days the soil was puddled and levelled.

Treatment of seeds and sowing. On July 19, 1947, the seeds were placed in a gunny bag and soaked in water for 24 hours, after which the bag, still containing the seeds, was placed in a shaded place for 48 hours to allow germination. On July 21, 1947, the sprouting seeds were sown in the seedbed, framed with bamboo to avoid destruction during heavy rains. Three paddies were prepared in an adjoining plot measuring 24 square meters. After the soil had been tilled and thoroughly pulverized and weeded, tap water from a faucet was run into it for about two weeks. Then the soil was puddled and levelled.

Sowing and transplanting. On June 27, 1947, the sprouted seeds were planted in rows directly in the field for upland culture. Three to five seeds were planted in each hill. A marked string was used to set the hills 30 centimeters apart in the rows. The seeds were dropped into the marked spots and then covered with soil.

In the pot culture the sprouting seeds were planted in quincunx, three to five seeds to a hill. The four corners were 10 centimeters from the sides of the pot and 30 centimeters apart. Germination was completed a week after the seeds had been planted directly in the upland and pot cultures and in the seedbed. The seedlings were uniform in growth, vigor, and color. On July 4, 1947, the young plants were thinned to one vigorous seedling to a hill, and the missing hills were replanted. The pots were watered twice a week, or whenever necessary.

On September 6, 1947, water was turned into the seedbed to soften the soil and to facilitate the pulling up of the seedlings. In 9 hours the soil was sufficiently softened to allow pulling up of the seedlings. The leaves were pruned to one-third their original height. The seedlings were brought to the prepared paddies, where with a marked string for a guide, they were planted one seedling to a hill. The hills were 30 centimeters equidistant.

Irrigation. After the transplanting, water was shut off to give the seedlings time to establish themselves in the soil. Water was turned in whenever necessary and was kept at a depth of about 5 centimeters in the paddies. Water was withdrawn whenever there was an excess, and the paddies were completely drained when the plants approached maturity.

Weeding. The three lots were weeded as often as it was necessary.

Height of plants. A week before harvesting, 50 plants in each culture were measured at random from the base of the culms to the tip of the panicle.

Tillering. The tillers were counted daily from their appearance to a week before the plants were harvested. The number of bearing and non-bearing culms in every stool was recorded.⁴

Harvesting. The shattering habit of the plants was noted before each culture was harvested, which was done when the panicles were all mature. The representative panicle from each of the 50 hills in each type of culture was labeled, placed in paper envelopes and allowed to dry in the sun for about two weeks, after which the length of the panicles was taken. Threshing was done by hand to avoid mixing the grains from different panicles. The filled and empty grains were counted and placed in separate envelopes.

The filled grains from each culture were cleaned and mixed. Exactly 2,500 grains were taken at random from each culture, and their lengths and widths were measured with a micrometer caliper.

The shape, color, and texture of hulled grain, and awn character of the grain were noted.

The presence and absence of pigments on leaf sheath, internode, glume, glume tip, stigma, and leaf were observed, and the exact color was determined by means of Ridgway's⁵ standards of color and nomenclature.

The habit of the straw (whether erect, intermediate, or prostrate) and the nature of the straw (whether long or short) were noted.

Analysis of morphological characters

Presence and absence of pigments. The pigments present in certain structures of the plants in one culture were similar to those present in similar structures of plants in the other cultures. The leaf sheath is Calliste green; the glume, Scheeles' green; the glume tip, blackish red purple; the stigma, black; and the leaf, spinach green.

Habit of straw. The plants in the three cultures were all of the erect type. Ramiah⁶ reported that the erect or compact habit of the rice straw is usually associated with a non-lodging nature. This tendency was also observed in the three types of cultures. Only a few plants were adversely affected by the storms in October and November, 1947.

⁴ Tillers in their immature or booting stage, even though attacked by pests, were considered bearing culms.

⁵ RIDGWAY, R. 1912. Color standards and color nomenclature, iii + 42 p., 53 plates. Baltimore, Md.: A. Hoen and Company.

⁶ RAMIAH, K. 1937. Rice in Madras. A popular handbook. viii + 244 p. Madras: Superintendent of Government Press.

Nature of straw and shattering habit. The three cultures produced short plants which, in turn, produced short straw. The short straw⁷ was characterized by a number of short internodes condensed at the lower end of the culms, close to the ground, and by a few elongated internodes near the top of the stem.

The shattering habit was determined before the panicles were threshed. The plants in all the cultures were found to be of the slightly shattering type.

Awn character, texture of grain and color of rice. The environment in the College did not materially affect the awn character of Fortuna rice. The grains from the plants grown under three kinds of culture were all awnless.

The hulled grain was long, hard, and semitransparent.

Comparative heights of plants. Plants grown under upland conditions were the tallest (table 1). They had a mean height of 118.90 ± 1.505 centimeters. The pot-culture plants had a mean height of 99.64 ± 2.203 centimeters, and the lowland or paddy-culture, 94.96 ± 0.695 centimeters. Statistical comparisons (table 8) among the heights of the plants from the three cultures showed that the differences were highly significant. This finding seems to be in accord with a well-established fact that although plant height is controlled by genetic factors, the expression of such factors is materially affected by environmental conditions.

Comparative lengths of panicles. Table 2 (fig. 1) shows the mean length of panicle of the three cultures. The panicles of the upland culture were the longest; they had a mean length of 30.24 ± 0.337 centimeters. The lowland culture had a mean length of 27.66 ± 0.551 centimeters. The pot culture, with a mean length of 21.96 ± 0.559 centimeters, produced definitely the shortest panicles as revealed by statistical comparison (table 8).

The relatively long panicles and the high percentage of filled grains produced by Fortuna plants grown under upland conditions compared favorably with those of plants from the pot and lowland (paddy) conditions, indicating that Fortuna rice is suitable for upland culture; that is, plants of upland culture yielded a significantly greater number of filled grains than those grown in the pot and lowland cultures, and produced a higher percentage of filled grains in each panicle.

Comparative sizes of grains. Table 3 shows mean lengths in millimeters of the grains in the three cultures, and table 4, the width. Statistically compared (table 8), mean differences in these measurements between any two of the three cultures were not significant. This suggests that size of grain is least affected by a change in environmental conditions.

The mean length of grain from the pot culture was insignificantly greater than that from the field-grown plants. The grains from plants of the lowland culture were the shortest.

⁷ *Ibid.*



Fig. 1 — Comparative lengths of representative panicles of (1) pot, (2) low-land, and (3) upland cultures of Fortuna rice.

The grains of the upland culture had a greater mean width than those produced from the pot and lowland cultures; however, their mean differences were not significant. Again, the mean width of grains from the lowland culture was the lowest.

Percentage of filled grains. Upland culture gave 70.14 per cent of filled grains, which was the highest percentage; the pot culture, 35.77 per cent; and the lowland culture, 35.34 per cent.

The upland-culture-grown plants produced twice as much filled grains as the pot or paddy-culture plants.

Observations on physiological characters

Comparative ages at flowering and maturity. Table 5 shows the comparative ages at flowering and maturity of the plants in the three cultures. Rice plants of the upland culture flowered in 97.7 days after sowing and matured in 127 days. Pot-culture rice plants flowered in 99.4 days and matured in 129 days, while lowland-culture plants flowered in 96.6 days and matured in 133 days.

Fortuna matured earlier under Los Baños conditions than when grown in the United States as reported by Jones (1941). In Arkansas, Fortuna took 142 days from seeding to maturity, 147 in Louisiana, and 148 in Texas under irrigated conditions.

Tillering capacity under three types of culture. The mean number of tillers in the three cultures is presented in table 6. Plants grown in pots, with a mean of 4.30 ± 0.226 , produced more tillers than those grown in the upland and lowland systems of culture, which gave a mean of 3.62 ± 0.222 and 3.66 ± 0.177 , respectively. Table 8 shows that the greatest number of tillers was obtained by the pot culture, which was significantly greater than that obtained from either the upland or the lowland culture. The difference, however, in the number of tillers produced by plants grown under upland conditions and that of plants grown under lowland conditions was significant.

The plants grown in pots had the highest mean number of bearing culms of 4.06 ± 0.196 ; those of the upland culture, 3.46 ± 0.199 ; and those of the lowland culture, 3.42 ± 0.149 . The statistical difference in production of bearing culms between the pot culture on one hand and the upland and lowland cultures on the other hand is significant, but that between the upland culture and the lowland culture was not significant.

Susceptibility to plant pest and disease. The red rice weaver *Lonchura ferruginosa jagori* attacked the rice plants in the three cultures. Plants in the upland culture were the most seriously affected, for they formed grains earlier than those in the pot and lowland cultures, which were not seriously attacked by the pest. Attempts were made to minimize the damage caused by the birds by placing scarecrows around the field, but these were not very effective. Dried panicles with empty grains caused by the rice

stem borer *Schoenobius incertellus* Walker and rice bug *Leptocorisa acuta* Thunberg were observed in the three cultures. No plant disease was observed attacking the cultures.

SUMMARY

1. Of the three types of cultures to which Fortuna was subjected, the upland-culture rice plants, with a mean height of 118.90 ± 1.505 centimeters, were the tallest; pot-culture plants came out second with a mean height of 99.64 ± 2.203 centimeters; and the plants in the lowland culture, with a mean height of 94.96 ± 0.695 centimeters, were the shortest. Statistical comparison of their mean differences showed that the upland-culture rice plants were significantly taller than those of either the pot or lowland cultures.

2. All the differences in mean length of panicle obtained from any two of the three cultures were highly significant. Upland culture plants had the longest panicles, with a mean length of 30.24 ± 0.337 centimeters; those from the lowland culture came out second, with a mean length of 27.66 ± 0.551 centimeters; and those from the pot culture, were the shortest, with a mean length of 21.96 ± 0.559 centimeters.

3. There was no significant statistical difference in mean length and width of grains between any two of the three cultures, indicating that the method of culture did not influence the dimensional measurements of Fortuna grains.

4. The highest percentage of filled grains was obtained from the upland culture, which was 70.14. The pot-culture plants produced 35.77 per cent, and those from the lowland culture, 35.34 per cent.

5. Upland-culture rice plants flowered in 97.7 days and matured in 127 days; the pot culture flowered in 99.4 days and matured in 129 days; and the lowland culture flowered in 96.6 days and matured in 133 days. It appears that Fortuna rice matures earlier under conditions in this college than it does under conditions in the rice stations in the United States. In Arkansas, it took 142 days from planting to maturity of the grains; in Louisiana, 149 days; and in Texas, 148 days.

6. Pot culture induced the production of more tillers and more bearing culms than the upland and the lowland cultures.

7. All cultures were attacked by pests, but not by any disease. It is safe to recommend Fortuna as suitable under Los Baños conditions for either non-irrigated or irrigated culture, preferably the former.

TABLE 1

Frequency distribution of height of 50 plants from each culture

CLASS RANGE	C U L T U R E S		
	Upland	Pot	Lowland
<i>centimeters</i>			
60- 68	—	2	—
69- 77	—	2	—
78- 86	—	6	—
87- 95	—	7	29
96-104	8	15	20
105-113	2	10	1
114-122	24	4	—
123-131	11	3	—
132-140	—	—	—
141-149	3	1	—
150-158	2	—	—
TOTAL	50	50	50

Variation constants

Mean	118.90 $\pm$ 1.505	99.64 $\pm$ 2.203	94.96 $\pm$ 0.695
s. d.	10.64 $\pm$ 1.064	15.57 $\pm$ 1.557	4.81 $\pm$ 0.481
c. v.	8.94 $\pm$ 0.894	15.63 $\pm$ 1.563	5.07 $\pm$ 0.507

TABLE 2

Frequency distribution of panicle length of 50 plants from each culture

CLASS RANGE	C U L T U R E S		
	Upland	Pot	Lowland
<i>centimeters</i>			
11-13	—	1	—
14-16	—	2	1
17-19	—	10	2
20-22	1	17	5
23-25	1	10	9
26-28	9	7	18
29-31	29	3	12
32-34	10	—	3
TOTAL	50	50	50

Variation constants

Mean	30.24 $\pm$ 0.337	21.96 $\pm$ 0.559	27.66 $\pm$ 0.551
s. d.	2.38 $\pm$ 0.238	3.95 $\pm$ 0.395	3.90 $\pm$ 0.390
c. v.	7.88 $\pm$ 0.788	18.00 $\pm$ 1.800	14.06 $\pm$ 1.406

TABLE 3

Frequency distribution of grain length of 50 plants from each culture

CLASS RANGE	C U L T U R E S		
	Upland	Pot	Lowland
<i>millimeters</i>			
7.0- 7.4	—	1	—
7.5- 7.9	—	—	—
8.0- 8.4	1	3	5
8.5- 8.9	—	2	2
9.0- 9.4	34	24	27
9.5- 9.9	4	3	8
10.0-10.4	11	16	8
10.5-10.9	—	1	—
TOTAL	50	50	50

Variation constants

Mean	9.45 $\pm$ 0.120	9.47 $\pm$ 0.077	9.32 $\pm$ 0.076
s. d.	0.42 $\pm$ 0.085	0.54 $\pm$ 0.054	0.54 $\pm$ 0.054
c. v.	9.03 $\pm$ 0.903	6.02 $\pm$ 0.602	5.79 $\pm$ 0.579

TABLE 4

Frequency distribution of grain width among 50 plants from each culture

CLASS RANGE	C U L T U R E S		
	Upland	Pot	Lowland
<i>millimeters</i>			
2.0-2.4	—	1	
2.5-2.9	—	1	
3.0-3.4	34	35	37
3.5-3.9	16	10	12
4.0-4.4	—	3	1
TOTAL	50	50	50

Variation constants

Mean	3.36 $\pm$ 0.032	3.33 $\pm$ 0.048	3.34 $\pm$ 0.034
s. d.	0.23 $\pm$ 0.023	0.34 $\pm$ 0.034	0.24 $\pm$ 0.024
c. v.	6.99 $\pm$ 0.699	10.27 $\pm$ 1.027	7.33 $\pm$ 0.733

TABLE 5
Comparative ages of flowering and maturity

CULTURES	DAYS FROM SOWING TO FLOWERING	DAYS FROM SOWING TO MATURITY
Upland	97.7	127
Pot	99.4	129
Lowland	96.6	133

TABLE 6

Frequency distribution of total number of culms produced by 50 plants from each culture

CLASS RANGE	C U L T U R E S		
	Upland	Pot	Lowland
1 - 2	12	3	8
3 - 4	25	31	30
5 - 6	11	9	12
7 - 8	2	7	—
TOTAL	50	50	50

Variation constants

Mean	3.62 $\pm$ 0.222	4.30 $\pm$ 0.226	3.66 $\pm$ 0.177
s. d.	1.57 $\pm$ 0.157	1.60 $\pm$ 0.160	1.25 $\pm$ 0.125
c. v.	43.37 $\pm$ 4.337	37.20 $\pm$ 3.720	34.26 $\pm$ 3.426

TABLE 7

Frequency distribution of bearing culms produced by 50 plants from each culture

CLASS RANGE	C U L T U R E S		
	Upland	Pot	Lowland
1 - 2	13	3	8
3 - 4	25	34	36
5 - 6	12	9	6
7 - 8	—	4	—
	50	50	50

Variation constants

Mean	3.46 $\pm$ 0.199	4.06 $\pm$ 0.196	3.42 $\pm$ 0.149
s. d.	1.41 $\pm$ 0.141	1.38 $\pm$ 0.138	1.05 $\pm$ 0.105
c. v.	40.80 $\pm$ 4.080	34.13 $\pm$ 3.413	30.81 $\pm$ 3.081

TABLE 8
Comparative variability of plant responses to different cultures

CULTURES	CHARACTERS	MEAN DIFF.	LEVELS OF SIGNIFICANCE		REMARKS
			5%	1%	
Upland — Pot	Plant height	19.26	5.26	7.02	Highly significant
Upland — Lowland		23.94	3.11	4.42	Highly significant
Pot — Lowland		4.68	4.64	6.19	Significant
Upland — Pot	Panicle length	8.28	1.30	1.74	Highly significant
Upland — Lowland		3.30	1.29	1.72	Highly significant
Pot — Lowland		5.70	1.57	2.10	Highly significant
Upland — Pot	Grain length	0.02	0.28	0.38	Not significant
Upland — Lowland		0.13	0.28	0.38	Not significant
Pot — Lowland		1.15	0.21	0.28	Not significant
Upland — Pot	Grain width	0.03	0.11	0.12	Not significant
Upland — Lowland		0.02	0.09	0.12	Not significant
Pot — Lowland		0.01	0.11	0.15	Not significant
Upland — Pot	Number of bearing culms	0.60	0.56	0.74	Significant
Upland — Lowland		0.04	0.49	0.66	Not significant
Pot — Lowland		0.64	0.49	0.65	Significant
Upland — Pot	Total number of culms	0.68	0.63	0.84	Significant
Upland — Lowland		0.04	0.56	0.74	Not significant
Pot — Lowland		0.64	0.57	0.76	Significant

RELATION IN DUCKS BETWEEN DURATION OF INCUBATION AND SEX¹

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In Pateros, Rizal, the center of the *balut* industry in this country, ducklings are sexed usually on the fourth day after the completion of hatching. The method used in sexing was described by Fronda and Cruz in 1931. It involves the careful inspection of the cloaca of the birds, an operation that requires experience. It may be possible to sex ducklings in a less exacting way by separating them as they come out of the egg shells on the day of hatching. The results of studies to find out whether or not there exists any relationship between the duration of incubation and sex are reported in this paper.

So far, no literature related to this study on ducklings is available. Recent reports on chickens, however, tend to show that there were likely to be more females than males among the chicks that hatched first (Dove, 1943). Smyth and Cairns (1944) also reported that female chicks predominated in the hatch of the first twelve hours and male in the hatch of the last twelve hours. There was an equal number of males and females near the middle of the hatch. Hays (1941) observed that chicks hatched earlier were predominantly female, of higher livability, and of better vigor and health than those hatched later. It was found further by Dove (1943) that, regardless of sex, chicks hatched early were healthier than those that hatched later.

THE STUDY

This study on ducklings was conducted from June, 1946, to May, 1947, in the hatchery of Mr. Tiburcio Tuason, the biggest hatchery in Pateros, Rizal. The sex of 7,338 ducklings hatched out of 10,500 uniformly large-sized, thick-shelled, selected eggs set at different times were observed.

Method used. The Pateros method of incubation described by Raymundo (1912) was employed, but when the incubated eggs were found through candling to develop irregular and unevenly-sized primary and secondary blood vessels, they were sold as *penoy* on the thirteenth day of incubation and as *balut* or *tañgaban* on the nineteenth day. The operators believe that such embryos are bound to die or, if hatched, will develop into weak ducklings. It is claimed

¹ Experiment Station Contribution No. 1505. The data presented in this paper were taken from the thesis presented by the junior author for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture, October, 1947.

that if these ducklings survive, the ducks will develop into poor and unthrifty layers. No record is available to substantiate this claim, but the observation has been handed down from generation to generation.

Ducklings hatched from each batch of eggs set at the same time were grouped into six lots, each lot being composed of birds hatched every four hours. The six lots were chronologically designated lots I to VI; that is, those chicks hatched during the first four hours were designated lot I; those hatched during the second four hours, lot II; etc. This grouping was adopted because operators of long experience have found that the best hatches are obtained when duck eggs are incubated so that the hatching is completed within twenty-four hours after the first ducklings have come out of their shells. The operators attain this uniform hatch by controlling the temperature of the incubators, especially during the last two weeks of incubation. While no record of actual incubation temperature was taken in this study, Tantoco (1933) and Burgos (1947) reported that the temperature of the heated palay used in the incubation ranged from 40° to 43°C.

The hatching table was visited at regular intervals during the hatching period. More frequent visits were made on the day when the eggs were expected to pip in order to ascertain the exact time of hatching of the earliest birds. After the eggs had started to hatch, the stronger ducklings were separated from the hatching eggs to prevent them from getting choked, and to regulate the temperature of the hatching eggs. Once in a while, the table space had to be widened to give the pipping eggs more room. In order to prevent any interference of the commercial aspects of the trade with the experiment, the permanent employees of the hatcheries were employed to do the work during the hatching period.

The ducklings that were strong enough to mingle with the others in their respective lots were removed from the hatching table. The wet ducklings that had recently been removed from the hatching table were dried in big bamboo baskets called *kaong* littered with rice straw. On the fourth day after the completion of the hatches, experienced workers of the hatcheries determined the sex of the birds of each lot according to the Pateros method (Fronda and Cruz, 1931).

As the female ducklings were distributed to duck raisers in Laguna and in Rizal, and the males were marketed, there was no way of checking on the efficiency of the sexing operation. It may be mentioned, however, that when 600 male ducklings were purchased by the College of Agriculture, University of the Philippines, for the use of this institution in other studies, only 2 ducklings, or 0.3 per cent of the total number, were found to be females.

DISTRIBUTION OF SEXES

Sex ratio of the ducklings. The preponderance of either sex was not statistically significant in any of the batches (table 1): 53.53 per cent were found to be males, and 46.46 per cent females. The difference in the distribution of sex among ducklings was practically nil and insignificant.

Sex ratio of ducklings hatched at different periods. It is apparent that the significance of preponderance of one sex varied in the individual lots of the different batches (table 2). The first lots of the different batches, for example, were either significant or insignificant as regards preponderance of one sex. The second and third lots were similar to the first in this respect. Lots IV, V, and VI of all the batches were, as a group, uniform in one respect, not one of them showing any significance as regards preponderance of one sex in any of the batches.

The month of hatch, when considered as an independent variable factor, did not influence the sex distribution of ducklings. It was found, however, that month and lot, as interacting factors, affected the sex distribution of ducklings in the different batches, that is, the significance of the preponderance of one sex in a given lot of a given batch was affected by the month during which the batch took place. To illustrate, in the second lot of the first batch, which was completed in September, females very significantly predominated; whereas, in the same lot of the second batch, which took place in November, neither sex predominated significantly. The change in the significance of the influence of month upon sex distribution of ducklings, when lots were also considered, may be explained by the fact that the sex distribution of ducklings within a batch varied significantly in each lot.

Influence of sequence of hatch on sex. Table 3 shows that the preponderance of females in lot I was statistically highly significant. In lot II, the same sex was predominating. In lots III and IV, neither sex was significant; and in lot VI, the preponderance of males was highly significant. The females, in this connection, were approximately 55 per cent in lot I, 53 per cent in lot II, 50 per cent in lot III, 48 per cent in lot IV, 47 per cent in lot V, and only 42 per cent in lot VI.

When all the batches were grouped into three 8-hour groups, as shown in table 4, and were treated similarly for the predominance of either sex in each group, it was found that during the first eight hours the preponderance of females was highly significant; during the second 8-hour period, neither sex was significantly preponderant; and during the last eight hours, males predominated very significantly. The percentage of sex in each group of eight hours of hatching was approximately 46 per cent males for the first group, 51 per cent for the second group, and 55 per cent males for the third group.

No available literature explains why the females predominated in the early period of the hatch and the males in the last period, but Hays (1941) and Dove (1943), working on chickens, found that birds that hatched early were more vigorous and healthier than those that hatched later. This health and vigor that the earlier hatched birds possessed may be one of the reasons for their ability to wriggle themselves out of their shells ahead of the others. In ducklings, as in chickens, it may partly explain the difference in the time of hatching.

Sex of the unhatched ducklings. Owing to a certain commercial practice of giving away unhatched eggs, locally known as *ukbo*, to customers and patrons of the trade, only 169 of this kind of eggs were available for this observation. All of these unhatched eggs were taken from the last batch of eggs incubated. Of the 169 *ukbos* that were opened and observed, 103 were males and only 66 were females. The males were found to be more decidedly predominant than the females, they being approximately 61 per cent of the group.

SUMMARY

1. The ratio of males to females among the ducklings observed in this experiment was 50.39 per cent males to 49.61 per cent females, a close fit to a 50:50 ratio.

2. The sequence of hatches of four-hour periods showed that the females occurred significantly in excess in the first two lots, males in the last two lots, and neither sex in the two middle lots. This trend was likewise observed in the sequence of the eight-hour periods of hatching. The females predominated very significantly during the first eight hours of hatch; neither sex predominated in the next eight hours; and males predominated during the last eight hours.

LITERATURE CITED

- BURGOS, C. X. 1947. Questions and answers on duck raising. *Farming and Co-operatives* 2 (1): 7-8.
- DOVE, W. FRANKLIN. 1943. Poultry breeding. *Maine Agri. Exper. Sta. Bull.* 420: 510-512.
- FRONDA, F. M., AND GAUDENCIO B. CRUZ. 1931. Preliminary studies on the possibilities of green duck production. *Philippine Agriculturist* 19: 591-600.
- HAYS, F. A. 1941. The importance of length of incubation period in Rhode Island Reds. *Massachusetts Agric. Exper. Sta. Bull.* 348: 1-12.
- RAYMUNDO, M. B. 1912. The duck and egg business of Pateros. *Philippine Agriculturist and Forester* 1: 56-59.
- SMYTH, J. ROBERT, AND GORDON M. CAIRNS. 1944. Length of incubation period in poultry as related to characteristics of progenies. *Maine Agric. Exper. Sta. Bull.* 426: 385-386.
- TANTOCO, C. B. 1933. Studies on the use of a Pateros hatcher in incubating chicken eggs. *Philippine Agriculturist* 22: 189-201.

TABLE 1
Proportion of males and females by hatches irrespective of lot

ITEMS	1ST HATCH		2ND HATCH		3RD HATCH		4TH HATCH		5TH HATCH		6TH HATCH		TOTAL	
	Males	Females	Males	Females	Males	Females	Males	Females	Males	Females	Males	Females	Males	Females
Number of ducklings	651	707	271	279	836	807	558	578	519	512	805	815	3640	3698
Number expected	679	679	275	275	821.5	821.5	568	568	515.5	515.5	810	810	3669	3669
X ²	2.304		.116		.512		.252		.048		.062		.458	
P	0.20-0.10		0.80-0.70		0.50-0.30		0.70-0.50		0.90-0.80		0.90-0.80		0.50-0.30	

TABLE 2
Sex distribution in individual hatches by lot

LOTS	1ST HATCH		2ND HATCH		3RD HATCH		4TH HATCH		5TH HATCH		6TH HATCH	
	Males	Females	Males	Females	Males	Females	Males	Females	Males	Females	Males	Females
I	87	73	49	63	156	192	93	131	69	98	151	189
X ²	1.225		1.750		2.574		4.660		5.036		4.248	
P	0.30-0.20		0.20-0.10		0.20-0.10		0.05-0.02		0.05-0.02		0.05-0.02	
II	206	260	52	56	160	170	109	119	77	85	152	167
X ²	6.257		.184		.302		.348		.396		.718	
P	0.02-0.01		0.70-0.50		0.70-0.50		0.70-0.50		0.70-0.50		0.50-0.30	
III	140	189	40	45	126	100	79	70	64	35	107	122
X ²	7.298		.394		2.991		.544		8.492		.982	
P	>0.01		0.70-0.50		0.10-0.05		0.50-0.30		>0.01		0.50-0.30	
IV	140	120	81	79	248	227	167	164	148	137	243	228
X ²	1.538		.025		.928		.027		.466		.478	
P	0.30-0.20		0.90-0.80		0.50-0.30		0.90-0.80		0.50-0.30		0.50-0.30	
V	78	65	29	21	81	68	71	63	139	143	89	65
X ²	1.182		1.280		1.134		.472		.156		3.740	
P	0.30-0.20		0.30-0.20		0.30-0.20		0.50-0.30		0.90-0.80		0.10-0.05	
VI	0	0	20	15	65	50	39	31	22	14	63	44
X ²	0		.714		1.856		.914		1.778		3.374	
P	0		0.50-0.30		0.20-0.10		0.50-0.30		0.20-0.10		0.10-0.05	

TABLE 3
Sex distribution in all hatches by lot

NUMBER	LOT I		LOT II		LOT III		LOT IV		LOT V		LOT VI	
	Males	Females	Males	Females	Males	Females	Males	Females	Males	Females	Males	Females
Observed	605	746	756	857	556	561	1027	955	487	425	209	154
Expected	675.5	675.5	806.5	806.5	558.5	558.5	991	991	456	456	181.5	181.5
X^2	14.716		6.324		0.22		.262		4.214		9.334	
P	>0.01		0.02-0.01		0.90-0.80		0.70-0.50		0.05-0.02		>0.01	

TABLE 4

Sex distribution in all hatches for periods of eight hours

NUMBER	FIRST 8 HOURS		SECOND 8 HOURS		THIRD 8 HOURS	
	Males	Females	Males	Females	Males	Females
Observed	1,361	1,603	1,583	1,516	696	579
Expected	1,482	1,482	1,549.5	1,549.5	637.5	637.5
X^2	19.758		1.448		10.736	
P	>0.01		0.30-0.20		>0.01	

SERAUP KECHIL 36 AND GUINANGANG AS PRIMARY CROPS IN SUCCESSION TO A SECONDARY RICE CROP¹

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In growing two rice crops a year, an early maturing variety is used as a secondary crop. It is planted in May to June and harvested in September to October. The regular or primary rice crop is planted in the seedbed in July to August, transplanted in September to October, and harvested in February to March. Seraup Kechil 36 has been found to be the best variety in the low-land rice fields of this College but it matures 172 to 175 days after broadcasting in the seedbed. Aragon and Cada² found that of the ten varieties of rice imported from the Federated Malay States, Seraup Kechil 36 and Seraup Kechil 146 were the highest yielders and the most promising for the Philippines. These writers also found that Seraup Kechil 36 matured, on the average of two plantings, six months after sowing. Calma and Cada³ found that Seraup Kechil 36, Seraup Kechil 146, Elon-elon A-5-36, and Elon-ram strain 8 gave significantly higher yields than either Elon-ram strain 3 or Elon-ram strain 6. The first four varieties, however, did not show much difference in yields. These writers also found that Seraup Kechil 36 matured 182 days after sowing in the seedbed. Guinangang, however, although not generally considered as good a yielder as Seraup Kechil 36, matures in about 155 to 160 days. An experiment was conducted from September, 1944, to February, 1945, in the Experiment Station of the College of Agriculture to determine which of the two varieties may be planted after harvesting a secondary rice crop.

EXPERIMENTS, RESULTS, AND DISCUSSION

The seeds of Seraup Kechil 36 were obtained from the Division of Annual Farm Crops, Department of Agronomy, and the seeds of Guinangang from Bay, Laguna. When tested for their viability, Seraup Kechil 36 gave 95 per cent germination and Guinangang, 98 per cent.

¹ Experiment Station Contribution No. 1506. Based on the thesis presented by the junior author for graduation with the degree of Bachelor of Science in Agriculture, October, 1945.

² ARAGON, VICENTE B., AND ESTEBAN CADA. 1939. A preliminary report on the performance of ten rice varieties from the Federated Malay States. *Philippine Agriculturist* 27: 635-646, *Fig. 1-4*.

³ CALMA, VALERIANO C., AND ESTEBAN CADA. 1941. Comparative test of six varieties of rice. *Philippine Agriculturist* 30: 548-554.

The lowland field used in this experiment was of clay loam soil and had an area of 4,000 square meters. The land had never been planted to any crop but rice. It was planted to a secondary rice crop which was harvested in October, 1944.

The field used included eight paddies which were numbered consecutively from one to eight. The plots were arranged at random to allow analysis of variance. Each paddy was rectangular in shape and had an approximate area of 500 square meters. The experiment was replicated four times.

On August 25, 1944, the seedbed was prepared by the ordinary wet-bed method. On September 1, 1944, the seeds were placed in a gunny sack, soaked in running water for 48 hours, and then placed in the shade for another 48 hours. On September 4, 1944, the sprouting seeds were broadcast in the seedbed at the rate of 20 gantas for every 500 square meters. Emergence of the seedlings took place five days after broadcasting.

The field was prepared in the ordinary way of preparing a lowland rice field. On October 28, 1944, when the seedlings were 54 days old, they were transplanted to the prepared paddies at the rate of two to three seedlings per hill. The hills were about 25 centimeters apart.

The paddies depended upon rain for water. As the depth of the water in the paddies ranged from five to fifteen centimeters only, the paddies were drained after heavy rains during the first few weeks after transplanting.

One and a half months after transplanting, the plants of the two varieties of rice began to exhibit marked differences in their growth and height. The two varieties differed significantly in their mean heights; Guinangang was significantly taller. Seraup Kechil 36, however, was more vigorous than Guinangang. Seraup Kechil 36 had a mean height of 124.86 centimeters and Guinangang, 130.80 centimeters.

Lodging and susceptibility to pests and diseases

Observation of the two varieties showed that Guinangang lodged more than Seraup Kechil 36.

Seedling blight caused by *Sclerotium rolfsii* Sacc. was observed on some plants of Guinangang in an advanced stage of growth. The damage, however, was small.

Percentage of bearing culms

Seraup Kechil 36 had a mean of 14.00 bearing culms per hill and Guinangang, 15.56. As shown by the analysis of variance, Guinangang had significantly more bearing culms per hill than Seraup Kechil 36.

Blooming and maturity periods

Guinangang matured earlier than Seraup Kechil 36. Guinangang flowered in 87 days and was harvested in 166 to 168 days after the seeds were broadcast in the seedbed. Seraup Kechil 36

flowered in 124 days and was harvested in 174 to 176 days from broadcasting. In the present study, however, the writers found that Seraup Kechil 36 matured 12 to 14 days earlier than the maturity period reported by Aragon and Cada in 1938; 14 to 16 days earlier than that noted by Calma and Cada in 1941; and 20 to 22 days earlier than that found by Villegas.⁴ The early maturity of Seraup Kechil 36 in this study may be attributed to its having been planted rather late.

Number of developed and undeveloped grains

The number of developed and undeveloped grains varied significantly between the two varieties. The mean number of developed grains for Seraup Kechil 36 is 105.21 and for Guinangang, 74.59; the mean number of undeveloped grains of Seraup Kechil 36 is 50.52 and for Guinangang, 27.27.

Yields of the two varieties

Table 1 shows that Seraup Kechil 36 gave a mean yield of 72.34 kilograms per plot of 500 square meters, whereas Guinangang gave a mean yield of 79.95 kilograms. Based on 44 kilograms per cavan, the computed yield per hectare of Seraup Kechil 36 was 32.88 cavans and Guinangang, 36.26 cavans. In the present work the yield of Seraup Kechil 36 was very much lower than that reported by Villegas,⁵ who obtained 73.69 ± 3.16 cavans per hectare, or a difference of 40.81 ± 3.16 cavans. Seraup Kechil 36 gave even a lower yield than Guinangang. This low yield of Seraup Kechil 36 may be attributed partly to delayed planting. Probably too, there was not sufficient moisture in the soil for the Seraup Kechil 36 plants to grow to maturity normally. These results suggest that if a secondary rice crop is to be grown in the College rice field, Guinangang should be used as the primary rice crop.

SUMMARY

1. Guinangang, with a mean height of 130.80 centimeters, is significantly taller than Seraup Kechil 36, with a mean height of 124.86 centimeters.
2. Guinangang lodged more than Seraup Kechil 36 and was infected slightly with seedling blight caused by *Sclerotium rolfsii* Sacc.
3. Seraup Kechil 36 produced more bearing culms than Guinangang. It flowered in 124 days and matured in 174 to 176 days after broadcasting in the seedbed, whereas Guinangang flowered in 87 days and matured in 166 to 168 days.

⁴ VILLEGAS, JORGE J. A comparative study of Seraup Kechil 36, Macan Señora, and Lamio. (Thesis presented for graduation with the degree of Bachelor of Science in Agriculture, 1944. Unpublished).

⁵ *Ibid.*

4. Seraup Kechil 36 gave a significantly greater total grain yield (developed and undeveloped grains) than Guinangang; however, Guinangang gave a significantly higher yield than Seraup Kechil 36.

5. The results suggest that if a secondary rice crop is to be grown in the College rice field, Guinangang should be used as the primary rice crop.

TABLE 1
Yields in kilograms of clean palay of the two varieties

P L O T S	VARIETIES		GRAND TOTAL
	S. K. 36	Guinangang	
Variety Mean	72.34	79.95	(609.05)
Computed yield per Ha. in cav. ^a	32.88	36.26	

^a Computed yield based on the average yield of all the plots of each variety

Analysis of variance

SOURCE OF VARIATION	DF	SUM OF SQUARES	VARIANCE	COMPUTED F-VALUE	(TABULAR F-VALUE)	
Total	7	3138.8097				
Varieties	1	46589.0184	46589.0184	6.43	5.99	13.74
Error	6	43459.2087	7243.2014			

EFFECTS OF COPRA MEAL ON CERTAIN CHEMICAL AND BIOLOGICAL PROPERTIES OF LOS BAÑOS CLAY LOAM¹

VICTORINO C. ANDRION

The effects of copra meal on the biological and chemical properties of Los Baños clay loam was studied in the Department of Soils, College of Agriculture, from May 20, 1947, to January 31, 1948.

Tabayoyong (1947) found that the effect of copra meal on Los Baños clay loam is decidedly better than that of ammonium sulfate as indicated by the growth, weight, and taste of the lettuce plants grown in lots treated with these two kinds of fertilizer. According to this author, the lettuce plants grown in Los Baños clay loam with copra meal were bigger and more vigorous than those grown in the control or in the ammonium-sulfate-treated lots. The copra meal made the soil dark brown, friable, porous, and easy to work with. Caray (1921) analyzed copra meal and found the following percentage of the different constituents in terms of air-dry sample: moisture, 11.19; ash, 5.39; protein, 20.94; oil, 14.13; water-soluble fatty acids, 7.07; crude fiber, 13.82; other carbohydrates, 24.90; undetermined elements, 2.50. According to Galvez, Moreno, and Lava (1928), Joajoco found that copra cake contains 19.89 per cent P_2O_5 and 8.14 per cent K_2O .

EXPERIMENTS, RESULTS, AND DISCUSSION

Surface soil of Los Baños clay loam, medium phase, collected from the farmstead of the U. P. Rural High School on the way to the coffee plantation, was used. It is sticky and plastic when moist but very friable when dry. According to Aristorenas (1937), this soil has an apparent specific gravity of 1.21, a real specific gravity of 1.27, a maximum water-holding capacity of 62 per cent, a pore space of 61 per cent, a volume expansion of 0.26 per cent, a pH of 7.38, and contains 0.06 per cent K_2O . Aquino and Orig (1941) found that this soil contains 0.0031 per cent nitrogen, 0.0107 per cent P_2O_5 , and 0.0313 per cent K_2O soluble in 1 per cent citric acid.

The copra meal used was an expeller product purchased in San Pablo City, and contained 15.91 per cent protein, 15.21 per cent crude fiber, and 34.26 per cent carbohydrates.

The College Yellow Flint corn was used as indicator of the fertility of the soil.

Ninety holes, each about 30.5 cm. in diameter, about 25 cm. deep, and dug one meter from each other served as pots. These holes were divided into nine lots of ten pots. Eighteen kilograms of the

¹ Experiment Station Contribution No. 1507. Prepared in the Department of Soils under the direction of Dr. Dionisio I. Aquino.

soil to which copra meal had been added at the rate of 160.32 grams in lot I, 140.28 grams in lot II, 120.24 grams in lot III, 100.20 grams in lot IV, 80.16 grams in lot V, 60.12 grams in lot VI, 40.07 grams in lot VII, and 20.04 grams in lot VIII, were placed in each of the 80 holes. Lot IX served as the control. When computed, these rates of application correspond to 20,000, 17,500, 15,000, 12,500, 10,000, 7,500, 5,000, and 2,500 kilograms of copra meal to the hectare, respectively. Enough water was added to each pot and then the soil allowed to age to effect decomposition of the copra meal.

Three kernels of corn were planted in each hole. The seedlings were thinned to one when they were about a week old.

As they matured the corn ears were picked, dried, shelled, and then weighed. The stalks were uprooted and thrown away. To determine the residual effects of the copra meal added, the content of the holes was mixed well and then planted again to the same variety of corn. The corn ears were harvested and handled in the same manner as in the first planting.

The total nitrogen and nitrate nitrogen content of the soil was determined in accordance with the procedures described by the A.O.A.C. (1935) and Fred and Waksman (Aquino, 1932), respectively. The phosphoric acid and potash were determined in a manner similar to those given by Morgan (1937).

The number of bacteria and of molds in the soil was determined by the usual plate method using the "modified albumen" agar medium of Brown (Aquino, 1932) and Waksman's synthetic agar medium (Aquino, 1932), respectively. The pH value of the soil was determined colorimetrically with the use of La Motte pH outfit.

Heights. The plants in the lot that received the highest amount of copra meal were the tallest after the first week. In the other lots the stand and rate of growth corresponded to the increasing amount of copra meal added to the soil. The control lot showed the poorest stand and appearance. The effects of the copra meal on the corn were similar to those noted by Vihar (1911) on the same variety of corn fertilized with N-P-K. In general, the plants grew better in the less acidic soil. The average heights attained by the plants in the first planting were greater than those in the second planting.

The heights of the corn in the different lots showed significant differences in the first planting, but insignificant in the second planting.

No serious pests and diseases attacked the corn during the entire period of growth. The plants with greater amounts of copra meal were more resistant to abnormalities in growth than those with less.

Age of maturity. The addition of copra meal greatly affected the time of tasseling and silking of the corn and the maturity of the ears. On the average, the tassels appeared in the fertilized lots of the first planting in 48 days, and in the control, in 52 days.

The silk of all the plants appeared in 4 to 7 days after the appearance of the tassel. The plants in the control lot tasseled a little later than those in the treated lots. Vibar (1911) reported the length of maturity of the College Yellow Kint corn as influenced by the application of N-P-K to be 107 days. This experiment showed that the corn in the lots fertilized with varying amounts of copra meal matured, on the average, 85 days in the first planting and 95 days in the second planting. In both cases, the plants in the control were among the latest to mature, and those with the greatest amounts of copra meal among the earliest. In the second planting, the silk and the tassel appeared a week later than in the first planting.

Yield. The yields of the corn in the first and second plantings varied with the addition of copra meal. When treated statistically, however, the variance in the first planting was not significant, although in the second planting it was significant. The gradual increase in yield in both plantings with the increase of copra meal applied seemed to show that more copra meal should be added to the soil in order to get significant effects. Furthermore, the plants in the lots with bigger amounts of copra meal generally yielded more grains than those in the lots with less. The plants in the control lot yielded very few grains, if any.

Nitrogen. The total nitrogen content of the soil showed a very marked increase after the first planting, with further rise after the second planting. This further increase may be attributed to nitrogen fixation as presumed by Pañganiban (1923) in connection with nitrification. In this work, the increase in total nitrogen was noted in the fertilized lots; but in the control, the total nitrogen decreased considerably after the first and second plantings. The increase in total nitrogen in the soil corresponded to the increase of copra meal added.

The nitrate-nitrogen content of the soil before the application of copra meal was more than that after the first and second plantings. This may be explained by the fact that, whereas ammonification is only slightly affected by soil acidity, nitrification is retarded (Pañganiban, 1926). It seems logical, therefore, to find the amounts of nitrate-nitrogen in the soil considerably decreased after the soil had been planted. The increase in nitrate content of the fertilized soil corresponded to the increase of the copra meal added.

The phosphoric acid and potash increased considerably with the addition of copra meal and in direct relation to the amount of copra meal added.

The pH-value of the soil was slightly increased by the addition of copra meal and also in direct relation to the amounts of copra meal used.

The addition of copra meal stimulated the growth of bacteria and molds in the soil. This result is in conformity with the findings of Aquino and Mañgahas (1937) in their studies of Nanhaya

clay loam as affected by the application of fertilizers and soil amendments. They stated that fertilizers and soil amendments have stimulating influence upon the microorganisms in the soil. It was also found that as the amount of copra meal added increased there was a corresponding increase in the number of bacteria and molds. After the first planting, the number of bacteria per gram of air-dry soil ranged from 5.1×10^6 to 17.7×10^6 , while that of the molds at the same pH ranged from 3.2×10^4 to 8.6×10^4 . After the second planting, however, at a pH range of 5.15 to 5.75, the number of bacteria per gram of air-dry soil ranged from 3.0×10^6 to 8.8×10^6 , while that of the molds, from 3.8×10^4 to 12.8×10^4 . This observation is in consonance with the statement of Emerson (1930) that the pH-value of the soil mass has definite influence on its biological functions. Apparently, the moisture content of the soil showed a favorable influence upon the bacterial numbers while the molds were unaffected. This is in agreement with the findings of Mohr (1933-1938), who noted that the best pH range for bacterial growth is from 5.5 to 7.5, and that for the molds from 3.5 to 5.5. The increase in the number of molds may be explained by the fact that molds are more able to resist strong acidity than the bacteria. It may also be attributed to the fact that the bacteria break down the organic matter from the copra meal and use it up. After the second planting, the number of bacteria in the soil was reduced.

SUMMARY

1. The pH-value of the soil fertilized with copra meal increased in direct relation to the increase in the amounts of copra meal added; the pH-values of the untreated soil decreased.

2. Copra meal had beneficial effects upon the growth of corn. The plants appeared better than those in the untreated lot. The effect of copra meal on the heights of the plants, however, was significant in the first planting but insignificant in the second.

3. The plants in the lots fertilized with larger amounts of copra meal were more resistant to abnormalities in growth than those in the lots with smaller amounts of copra meal, including control.

4. The majority of the plants grown in the lots fertilized with copra meal showed a tendency to mature earlier than those in the control lot.

5. Copra meal added to the soil caused a gradual increase in yield corresponding to the amounts of copra meal applied.

6. The ears produced by the corn in the lots treated with larger amounts of copra meal were more fully developed than those in the lots with less fertilizer. In the control, several plants produced very little or none at all.

7. The increase in yield was more significant in the second planting than in the first one, although quantitatively, the total yield in the second planting was much less than that in the first.

8. The total nitrogen and nitrate-nitrogen content of Los Baños clay loam soil was increased by the addition of copra meal. The increase of the total nitrogen was greater than of the nitrate-nitrogen.

9. The addition of copra meal to the soil increased both the phosphoric acid (P_2O_5) and the potash (K_2O) contents of the soil.

10. The growth and activities of bacteria and molds were stimulated by the addition of copra meal to the soil. The bacteria increased from pH 5.5 to 7.5 and the molds, from pH 3.5 to 5.5.

LITERATURE CITED

- A. O. A. C. 1935. Official and tentative methods of analysis of the association of official agricultural chemists. 3rd ed. xvii 593 p. Washington, D. C.: Association of Official Agricultural Chemists.
- AQUINO, DIONISIO I. 1932. A microbiological study of forest and non-forest soils at the College of Agriculture. *Philippine Agriculturist* 21: 83-95.
- AQUINO, DIONISIO I., AND P. B. MAÑGAHAS. 1937. The effects of application of certain fertilizers and soil amendments on the number of microorganisms in Nanhaya clay, local alluvial soil. *Philippine Agriculturist* 26: 411-424.
- AQUINO, DIONISIO I., AND ROSARIO M. ORIG. 1941. Biological and chemical properties of some soil types at the College of Agriculture. *Philippine Agriculturist* 30: 528-540.
- ARISTORENAS, ISAAC J. 1937. A study on certain physical and chemical characteristics of some Maquiling soils. *Philippine Agriculturist* 26: 542-552.
- CARAY, ELIAS M. 1921. The chemical composition of copra meal with special reference to the nature of its carbohydrates. *Philippine Agriculturist* 10: 55-68.
- EMERSON, PAUL. 1920. Principles of soil technology. xv + 402 p., 34 fig., 9 charts. New York: The MacMillan Company. (p. 307.)
- GALVEZ, N., R. MORENO, AND V. G. LAVA. 1928. Chemical studies on coconut products: II. Utilization of coconut. *Philippine Agriculturist* 17: 163-168.
- MOHR, E. C. JUL. 1933-1938. The soils of equatorial regions with special reference to the Netherlands East Indies. Translated from the Dutch by Robert L. Pendleton. xii + 766 p. Michigan: Edwards Brothers, Inc.
- MORGAN, M. F. 1937. The universal soil testing system. *Connecticut Agric. Exper. Sta. Bull.* 392: 1-59.
- PAÑGANIBAN, ELIAS H. 1923. Rate of decomposition of organic nitrogen in rice paddy soils. *Philippine Agriculturist* 12: 63-75.
- PAÑGANIBAN, ELIAS H. 1926. Effect of acidity on the activities of microorganisms of the soil. *Sugar News* 7: 902-905.
- TABAYOYONG, FILOMENO T. 1947. The effects of the addition of copra meal to Los Baños clay loam. *Philippine Agriculturist* 31: 52-59.
- VIBAR, TORIBIO N. 1911. The influence of N-P-K on the growth and production of corn. *Philippine Agriculturist and Forester* 1: 175-187.

COLLEGE AND ALUMNI NOTES

Mr. José F. Zamora, an alumnus of the College, Class of 1911, endowed a professorial chair to the College of Agriculture. The donor was formerly a member of the Board of Regents of the University of the Philippines. Dr. Rafael B. Espino, '15, head of the Department of Agricultural Botany, has been assigned the professorial chair.

The American delegates to the Regional Trade Conference, headed by Mr. W. P. F. Brawner, of San Francisco, visited the campus on July 5, 1948. They were accompanied by members of the Philippine Chamber of Commerce.

The school year 1948-1949 was opened with a program at the Botany Auditorium on the morning of June 28.

Mr. Justo de la Paz, Jr., a recent graduate of the College of Liberal Arts, U. P., major in zoology, was appointed assistant instructor in the Department of Entomology on June 25, 1948.

A total of 122 students was enrolled during the summer session. Of this number, three were from foreign countries.

Mr. Apolinario Carañgal, Jr., '48, *cum laude*, has been appointed assistant instructor in the Department of Agricultural Chemistry, vice Mr. Enrique O. Bondoc, resigned.

In a meeting of the College faculty on June 15, 1948, the recommendation for graduation of Leonardo G. Banzon, Maximo B. Capito, Orencio M. Lawas, Francisco C. Reyes, Manuel A. Roa, Jr., and Jesus V. Tale was approved.

With the release of War Damage funds, the reconstruction of several College buildings has been expedited. The Rural High School building was completed and inaugurated on August 26, 1948. The work on Plant Pathology, Chemistry, Infirmary, Maquiling School, Animal Husbandry, and Agronomy nursery is underway.

The enrollment in the College for the first semester of 1948-1949 academic year reached a total of 364, which is 67 more than that of the previous year. Of this number, 134 are freshmen; 83, sophomores; 48, juniors; 49, seniors; 7, postgraduate students; 3, special students; and 40, cross-registrants from the School of Forestry.

The U. P. Rural High has a total enrollment of 209, of which 72 are girls.

Undersecretary José S. Camus, '14, left recently for the United States to assist Ambassador Elizalde and Secretary Cuaderno in securing a loan of ₱176,000,000 for the industrialization program of the Philippines.

Dr. Pablo N. Mabbun, '23, Philippine trade representative in Tokyo, returned to Manila recently in order to confer with government authorities concerning the future trade relation of the Phil-

ippines with Japan. Dr. Mabbun was formerly with the Department of Agricultural Economics of the College.

The following alumni of the College of Agriculture are among the government pensionados who were sent to take advance work in the United States: Julian Bulanadi, '35, in agricultural engineering in the Iowa State College; Ernesto T. Rigor, '36, in mechanized farming in the College of Agriculture at Davis, Colorado; Hilario J. Santos, '36, in vocational education at the Colorado Agricultural and Mechanical College at Fort Collins; and Crispin Las Marias, '36, instructor in the U. P. Rural High School, in mechanized farming in the Agricultural and Mechanical College in Texas.

Mr. Alfonso Eusebio, '44, assistant instructor in the Department of Entomology, resigned and left on July 6 for the United States to study dairy bacteriology in the Iowa State College at Ames.

Dr. Joseph E. Spencer, associate professor of geography in the University of California at Los Angeles, on sabbatical leave, visited the College of Agriculture recently.

In the 177th regular scientific meeting of the Los Baños Biological Club held on July 30, 1948, the following papers were read and discussed: "Control of *Rhizoctonia* damping-off of agoho (*Casuarina equisetifolia* Forst.) by soil treatment and by special growing media," by F. Tamolang and Prof. E. F. Roldan of the School of Forestry; and "A system of solvent extraction for coconut oil," by Mr. A. R. Carañgal, Jr. and Dr. Julian Banzon of the Department of Agricultural Chemistry.

Two students, Rosy Baltazar, postgraduate, and Aquilina Dy, sophomore, have been awarded the University scholarship and six, José O. Juliano, of the Laguna Institute, Calamba; Primo G. Macasaet, of the Palawan High School; Pacifico P. Namocale, of the Catarman Agricultural High School, Samar; Salvador P. Neric, of the Guinobatan Rural High School, Albay; Abelardo R. Nicdao, of the Silliman University (High School Department); and Reynaldo C. Rodriguez, of the Palawan Provincial High School, the entrance scholarship for the first semester, 1948-1949.

Jorge Juliano has been awarded the Madrigal scholarship.

Dr. F. O. Santos, chairman of the sub-committee on Bailon-de la Rama scholarship in agriculture, announced that, "A competitive examination for the selection of a Bailon-de la Rama scholar in agriculture will be given in the College of Agriculture in July, 1949. Applicants must have finished at least the first year of the College of Agriculture curriculum or its equivalent. Only applicants with good scholarship will be considered. The stipend of the scholar is ₱40.00 a month, plus ₱150 a year for fees, books, etc."

Mr. Eladio Sablan, '14, died of cerebral hemorrhage on July 28, 1948. Interment took place the next day in Pasig, Rizal. Mr. Sablan had long been connected with the Bureau of Plant Industry.

THE EXPERIMENT STATION

LIST OF AVAILABLE CIRCULARS AS OF SEPTEMBER, 1948

- No. 2.—Bud Rot of Coconut By *G. O. Ocfemia*
- No. 8.—Horse Breeding in the Philippines By *V. Villegas*
- No. 10.—Practical Directions for Coffee Planting *By Pedro A. David*
(Revised by Charles Fuller Baker, Dean, College
of Agriculture, 1917-1927.)
- No. 11.—The New College Copra Drier—Prepared
in the Department of Agricultural Chemistry
with the Cooperation of the Department of Agronomy
and Extension (Revised) By *Moises M. Kalaw*
- No. 17.—College Trapnest By *F. M. Fronda and P. S. Paje*
- No. 18.—Surveying for Area with a Surveyor's
Staff By *Alexander Gordon*
- No. 23.—Curing Pork and Making Sausage for
Home Use By *Mariano Mondoñedo*
- No. 24.—Construction and Operation of Silos in the
College of Agriculture By *J. P. Esquerro*
- No. 26.—Training cattle and carabaos
for work By *Valente Villegas*
- No. 28.—Cotton Culture By *Eulalio P. Baltazar*
- No. 29.—Collegiate Education in Agriculture *By Leopoldo B. Uichanco*
- No. 30.—What Should Filipino Ornamental Gardens
and Ornamental Plants Be? By *N. B. Mendiola*
- No. 32.—Hog raising (Revised,
mimeographed) By *Mariano Mondoñedo*
- The price of the circulars listed above is thirty centavos (₱0.30) each.
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